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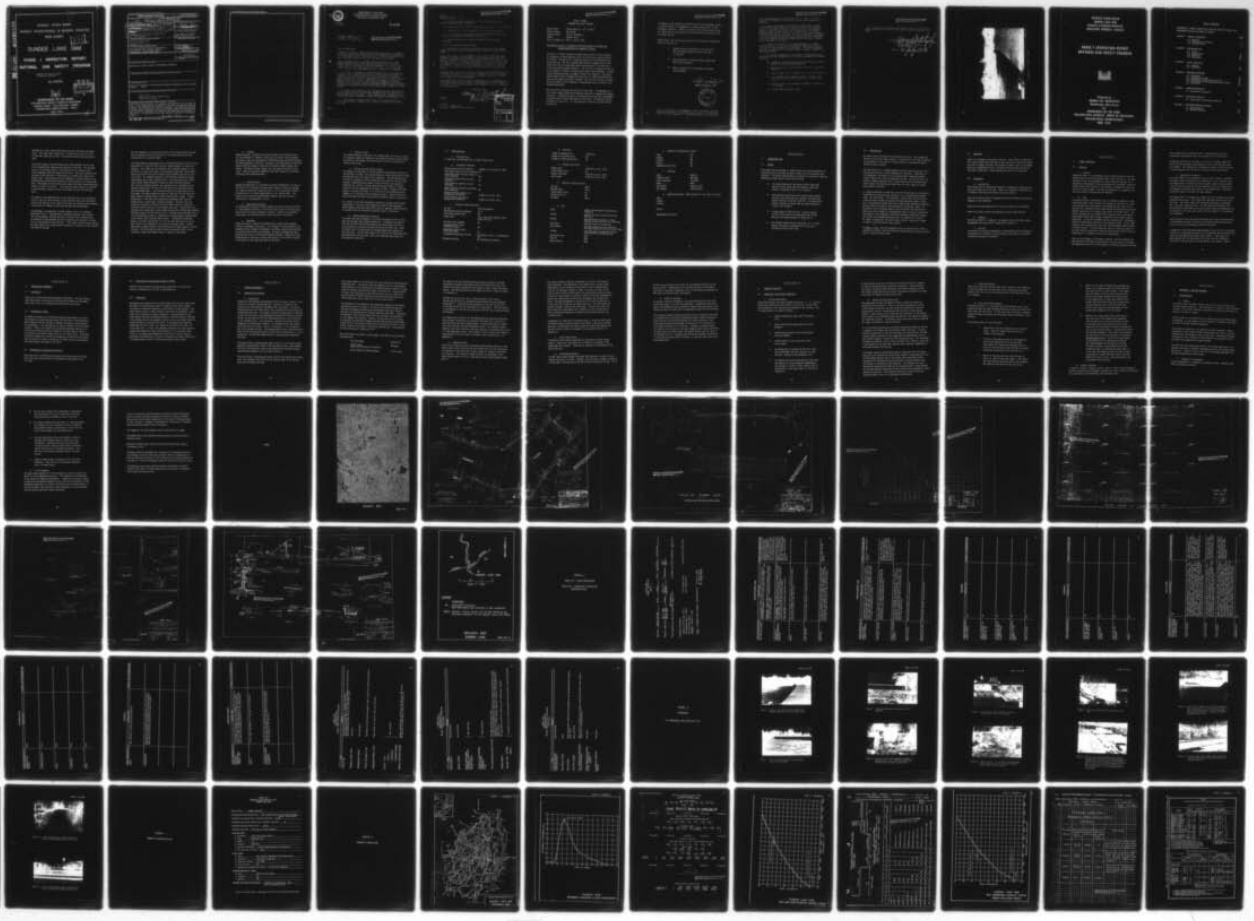

PASSAIC RIVER BASIN

PASSAIC RIVER, PASSAIC & BERGEN COUNTIES

NEW JERSEY

LEVEL II

DUNDEE LAKE DAM

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Approved for public release;
distribution unlimited

NJ 00243

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE - 2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

JUNE 1978

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National Dam Safety Program Phase I
Dundee Lake Dam, N.J.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's a quacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investig includes visual inspection, review of available design and construction and preliminary structural and hydraulic and hydrologic calculations, a applicable. An assessment of the dam's general condition is included i report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE - 2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-D

31 JUL 1978

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Dundee Lake Dam in Passaic and Bergen Counties, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given on the first four pages of the report.

Based on visual inspection, available records, calculations and past operational performance, Dundee Lake Dam is judged to be in poor condition. The dam's spillway is considered inadequate as 57 percent of the Probable Maximum Flood (PMF) would overtop the dam. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. Studies to determine the spillway's stability and to increase the spillway's capacity and for rehabilitation of the existing gate house or to provide a new low level facility should be initiated and completed within one year from the date of approval of this report. Remedial actions deemed necessary as a result of these studies, should be initiated in calendar year 1979. Due to the potential for overtopping of the dam, detailed emergency operation, warning and evacuation plans should be developed and placed in operation within two months from the date of approval of this report.

b. Studies to determine the structural adequacy of the timber bulkhead and miter gate should be initiated and completed within one year from the date of approval of this report. These studies should be performed in conjunction with spillway stability analyses recommended in paragraph a. above.

c. The following remedial actions should be initiated within six months from the date of approval of this report and completed in calendar year 1979.

(1) Regrade the area downstream of the left abutment and protect against erosion and slope instability.

(2) Make provisions to control surface runoff from River Drive, Garfield.

(3) Repoint eroded joints in masonry on left and right abutments.

(4) The riverward canal embankment should be cleared of uncontrolled brush growth and replaced with suitable ground cover.

(5) Upgrade Operation and Maintenance procedures by issuing an O & M Manual.

(6) Install head and tailwater gages.

d. Provisions for continuous monitoring and logging of left abutment seepage should begin within four months from the date of approval of this report.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Andrew Maguire of the Seventh District and Congressman Robert A. Roe of the Eighth District. Under the provisions of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, thirty days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia, 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely yours,

Harry V Dutchyshyn

HARRY V. DUTCHYSHYN
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Cy Furn:
Mr. Dirk C. Hofman, P.E.
Department of Environmental Protection

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Dundee Lake Dam, I.D. NJ 00243
State Located:	New Jersey
County Located	Passaic and Bergen
Stream:	Passaic River
Date of Inspection:	May 3, 5 and 6, 1978

Assessment of General Condition of Dam with Respect to Safety and Recommended Action with Degree of Urgency

The safety of Dundee Lake Dam is questionable because it has a seriously inadequate spillway capacity, which can safely pass only 56 percent of the PMF. The dam was in a severely neglected and dilapidated state when inspected. The left abutment shows signs of seepage and has been vandalized, and the downstream channel bank adjacent to the abutment is in an unacceptable eroded condition. The spillway is undercut at the toe and its general stability is questionable under high discharges. An additional engineering study is needed to assess its stability. The canal intake timber closure bulkhead and gates are in a deteriorated condition and of questionable structural strength. The low level outlet is inoperative and repairs are in progress to permanently block it, which is considered undesirable.

On the positive side, the dam has stood since 1854. The new owner is a major water supply company with adequate resources to upgrade its present condition. A program of repairs and rehabilitation has been independently started after this field inspection was completed. The program is fully described in Section 6.1 - a. and corrects a number of the deficiencies cited above.

A program of data acquisition including wash and core borings, within a 12-month period, is recommended to resolve uncertainties in the structural stability. Studies to increase the spillway capacity and for rehabilitation of the gate house should also be completed within a 12-month period.

Among actions that can be taken within 6 to 12 months to improve the safety of the dam are:

1. Regrade the area downstream of the left abutment and protect against erosion and slope instability.

2. Make provisions to control surface runoff from River Drive, Garfield.

3. Repoint eroded joints in masonry on left and right abutments.

Robert Gershowitz, P.E.

Robert Gershowitz, P.E.

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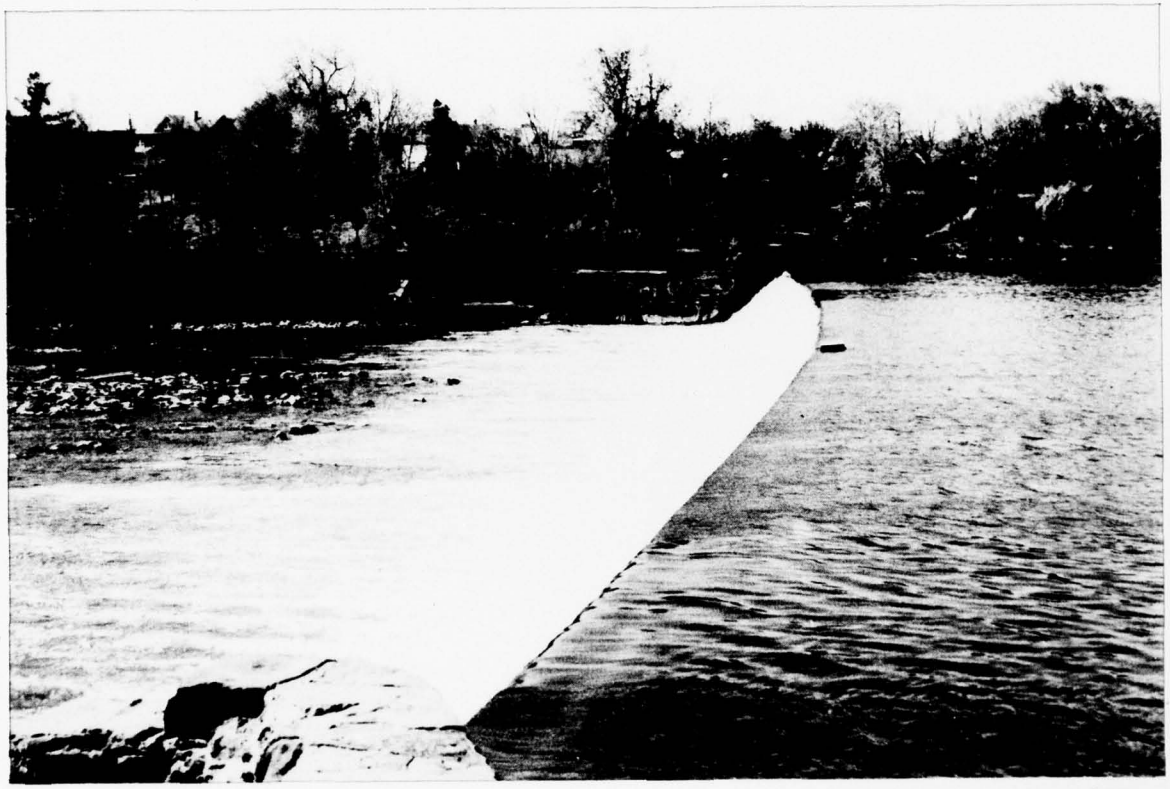
APPROVED: Harry V. Dutchyshyn
HARRY V. DUTCHYSHYN
Colonel, Corps of Engineers
District Engineer

DATE: 31 July 1978



May 1978

DUNDEE LAKE DAM

PASSAIC RIVER BASIN
DUNDEE LAKE DAM
PASSAIC & BERGEN COUNTIES
INVENTORY NUMBER: NJ00243

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared by
HARRIS-ECI ASSOCIATES
Woodbridge, New Jersey
for
DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA
JUNE 1978

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ASSESSMENT OF GENERAL CONDITION OF DAM WITH RESPECT TO SAFETY AND RECOMMENDED ACTION WITH DEGREE OF URGENCY

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NATIONAL DAM SAFETY PROGRAM

DUNDEE LAKE DAM, I.D. NJ 00243

SECTION 1

1. PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August 1972 authorizes the Secretary of the Army, through the Corps of Engineers to initiate a national program of dam inspections. Inspections for Dundee Lake Dam were carried out under Contract DACW61-78-C-0100 to the Department of the Army, Philadelphia District, Corps of Engineers, by the engineering firm of Harris-ECI Associates of Woodbridge, New Jersey.

b. Purpose of Inspection

The purpose of the inspection and evaluation is to identify conditions which threaten the public safety and thus permit the correction of the conditions in a timely manner by the owners. The National Inventory of Dams will be updated by the data acquired during the inspection.

1.2 Description of Project

a. General Description of Dam and Appurtenances

Dundee Lake Dam consists of a central spillway flanked on the left abutment by a concrete gravity wall tying into higher ground, and on

the right by a canal intake controlling the water flowing into Dundee Canal. The right canal intake wall is turned inland, and continues to form the right bank cut-off. The dam and canal were constructed in 1854.

The entire length of the dam between the right abutment and the left wall of Dundee Canal comprises the spillway of the dam. The spillway crest is at elevation 25.40. The elevation of the spillway crest varies somewhat along the length of the crest. The total length of the spillway is 450 feet and is constructed on a smooth long radius horizontal curve. The spillway from left abutment to right abutment is an uncontrolled overflow broad crested weir having steps on its downstream face. The height of the spillway crest above the normal downstream water surface is about 13-14 feet. The reservoir water surface is normally at the elevation required to pass the stream flow over the spillway crest.

The steps on the downstream face of the spillway serve as an energy dissipator. When the water surface in the reservoir rises above the elevation of the spillway crest, water spills over the spillway and dissipates a portion of its energy on the steps and then flows downstream.

The spillway is constructed of rubble masonry with a cut sandstone downstream facing. From available information sources, the upstream face of the masonry spillway section is vertical and is backed up by an earthfill on the upstream face that originally was placed at a slope of 2 or 3 horizontal on one vertical. This slope, in more recent surveys, has been found to be flatter, possibly because of siltation in the 120-year life span of the dam.

The left abutment is of the gravity type with cut stone masonry facing, and is separated from the spillway by a cut stone masonry spillway training wall of variable height.

The right abutment appurtenance works include the intake facilities for the Dundee Canal, a two-mile long raw water supply channel for industrial purposes. The intake has two channels; the riverward channel is controlled by a wooden miter-gate in deteriorated condition, which permits water to pass into the canal through vertical paddle gates built into its leaves. The landward channel is controlled by inoperative wooden sluice gates now in the closed position. The sluice gates are framed into a heavy timber bulkhead structure of deteriorating condition. The river and landward channels are separated by an intermediate cut-masonry dividing wall for the first 100 feet or so, and then combine into the Dundee Canal. The riverward channel wall downstream of the miter-gate has been lowered to provide a side weir for the control of water levels in Dundee Canal at higher Passaic River stages. Further downstream, on the canal berm separating the Dundee Canal from the Passaic River, a gate house has been provided. The gate house was originally intended to control the canal water surface, to provide a low level outlet facility, and to dewater the canal. The gates in this structure are inoperative in the closed position and leaking approximately 250 gpm of water into the Passaic River. The gate house and gates are in ruin and completely useless. Downstream of the gate house, Dundee Canal turns inland, away from the Passaic River. Downstream of Ackerman Avenue in Clifton, New Jersey, it is so far away from the river as to bear little or no relation on the safety of the dam itself. Further downstream at Monroe Street, the Dundee Canal has been placed in culvert and pipe. The flow from the Canal rejoins the Passaic River in the vicinity of South and Seventh Streets in Passaic, New Jersey.

b. Location

Dundee Lake Dam is located on the main channel of the Passaic River. Its left abutment is located in the City of Clifton, Passaic County, New Jersey, near the intersection of Randolph Avenue and Clifton Avenue. The right abutment of the dam is located at the intersection of Division Avenue and River Avenue in the City of Garfield, Bergen County, New Jersey. The Bergen-Passaic County line runs down the center of the river. There are numerous commercial and light industrial facilities located on both downstream banks.

c. Classification

Dundee Lake Reservoir is classified as being "Intermediate" in size on the basis of its reservoir storage volume, which is less than 50,000 acre feet but more than 1,000 acre feet. It is classified as "Small" on the basis of its total height which is less than 40 feet. The larger of the two size determinations governs, and thus the dam is classified as "Intermediate" in size.

d. Hazard Classification

In the National Inventory of Dams, Dundee Lake Dam has been classified as High Potential Harzard on the basis that failure of the dam would cause excessive property damage to commerce, industry and residences downstream, and could potentially cause more than a few deaths.

e. Ownership

Dundee Lake Dam is owned by the Dundee Water, Power & Land Company, located in Weehawken, New Jersey. This company is wholly owned by the Hackensack Water Company of Weehawken, New Jersey, having been acquired by purchase within the current decade. The dam is operated and maintained by the forces of the Hackensack Water Company. Ownership of the piped portion of the Canal, along South Street, is not firmly resolved in the minds of the operating staff of the owner.

f. Purpose of Dam

The current purpose of the dam is to impound water for use as a source of raw water supply for commercial and industrial plants located along the banks of the Dundee Canal downstream of the dam in Clifton and Passaic, New Jersey.

g. Design and Construction History

No accounts are available as to the design or construction history of the dam built in 1854. No original design or construction data has been recovered during this Phase of the inspection. The dam foundation at the toe was surveyed in 1870 to determine the extent of dam toe undercutting. Undercutting was found in several places, and apparently repaired, but similar or lesser undercutting was found in a recent survey of the toe conducted by the owner in 1974. A copy of the 1870 report, in handwritten form, is in the files of the Hackensack Water Company, as is the more recent inspection report. Copies of both reports were made available to Harris-ECI during the Phase I Inspection.

As a result of the 1974 foundation inspection, and more recent annual inspections of the dam by the engineering staff of the Hackensack Water Company, plans have been drawn up for a temporary rehabilitation of the dam which are discussed in greater detail in Section 6.

h. Normal Operational Procedure

The normal operating procedure is to allow the Passaic River to flow over the spillway crest without regulation. Flashboards surveyed in 1939 for the WPA's New Jersey Riparian and Stream Survey are not in use currently and no plans have been discussed for their use. Water in Dundee Canal is being drawn off through paddle gate openings in the miter gate. The low level outlet facilities on the right bank gate house downstream of the Canal Intake are inoperable and useless for upstream pool regulation.

1.3 Pertinent Data

a. Drainage Areas

At dam site, the drainage area is 809.9 square miles.

b. Discharge at Damsite

Maximum known flood at damsite:	35,800 cfs on October 8, 1903
Warm water outlet at pool elevation:	NA
Diversion tunnel low pool outlet at pool elevation:	NA
Diversion tunnel outlet at pool elevation:	NA
Gated spillway capacity at pool elevation:	NA
Gated spillway capacity at maximum pool elevation:	NA
Ungated spillway capacity at maximum pool elevation:	13,000 cfs at elev. 29.4
Total spillway capacity at maximum pool elevation:	13,000 cfs at elev. 29.4

c. Elevation (feet above MSL)

Top dam:	34.8 (estimated)
Maximum pool-design surcharge:	29.4
Full flood control pool:	NA
Normal pool:	Elev. 25.40 plus depth of river water over weir
Spillway crest (gated):	NA
Upstream portal invert diversion tunnel:	NA
Downstream portal invert diversion tunnel:	NA
Streambed atcenterline of dam:	Estimated at Elev. 7 at downstream toe
Maximum tailwater:	No information available

d. Reservoir

Length of maximum pool:	5,000 feet
Length of recreation pool:	NA
Length of flood control pool:	NA

e. Storage (acre-feet)

Normal pool:	2,584 AF at elev. 25.40
Flood control pool:	NA
Design surcharge:	4,700 AF at elev. 29.40
Top of dam:	7,200 AF at elev. 34.8

f. Reservoir Surface (acres)

Top dam:	600 A
Maximum pool:	333 A
Flood control pool:	NA
Recreation pool:	NA
Spillway	224 A

g. Dam

Type:	Rubble filled masonry faced gravity structure
Length:	Approx. 545 feet, out-to-out of cut-off walls
Height:	Maximum height is approx. 21 feet measured at the toe, 14 ft. at the heel
Top Width:	Spillway crest is 4-foot wide
Side Slopes:	Spillway masonry U/S face vertical; D/S face 1H:IV; U/S fill on 3H on 1V slope
Zoning:	Concrete masonry downstream section with earthfill on upstream side
Impervious core:	None
Cut-off	None
Grout curtain:	None

h. Diversion and Regulating Tunnel

Type:	NA
Length:	NA
Closure:	NA
Access:	NA
Regulating Facilities	NA

i Spillway

Type:	Masonry
Length of weir:	450 feet
Crest elevation:	25.40 MSL
Gates:	None
U/S channel	Passaic River
D/S channel	Passaic River

j. Regulating Outlets (None operable on the inspection date)

Type:

Length:

Closure:

Access:

Regulating facilities:

SECTION 2

2. ENGINEERING DATA

2.1 Design

No original design drawings or sketches have been uncovered despite an intensive search involving the owner, federal and state agencies and libraries. No design computations are available for checking or referral. Available drawings found in the search include:

- Two record drawings of the Passaic River Stream and Riparian Survey dated 1936 and completed under WPA auspices. (Drawings 2 and 3, see "Plates").

- Three drawings furnished by the current owner showing the dam cross section and the upstream and downstream channel sections at 25-foot intervals. The downstream channel profiles are dated 1905 and 1906 (Drawings 4, 5 and 6, see "Plates").

- A sketch made in 1870 by Stuart Lindsley showing erosion of the rock on the downstream side of the dam and the proposed method for repairing it.

- Two sketches made by Charles Worischek, P.E. in 1974, showing the extent of undercutting of the toe of spillway section at that time.

2.2 Construction

No record exists relating to the construction of dam. Even though the dam was at the time a major project, no mention of it has been uncovered in periodicals of the time in a library search at the New York Public Library historic section.

The 1870 report by S. Lindsley mentions the fact that the dam was 13 ft. high and was built on a level foundation of red shale. Subsequent to its completion, the action of the cascading water apparently eroded softer layers of this shale and undercut the dam. In order to halt this erosion, Lindsley mentions that a timber apron and fill concrete were used to repair the downstream eroded area, but this repair was swept away within a few years.

S. Lindsley proposed to extend the cut stone facing down to the bottom of the eroded area, continuing the spillway's 1V on 1H downstream stepped slope. Mr. Worischek's 1974 underwater survey shows that this repair could have been carried out because the downstream dam height at the toe is significantly higher than the 13-foot height reported by Lindsley, going as high as 20 feet to the underside of cut masonry stone. Mr. Worischek has an alternate theory, which maintains that the dam originally was built deeper on the downstream side, in order to extend the face down to a more competent and harder sandstone foundation stratum. As of 1974, the extended downstream face is undercut by as much as 24 inches in depth near the canal intake, and by 4 inches to 6 inches in depth in the left half of the spillway.

It appears likely that the downstream face was repaired after 1870 as proposed by Lindsley, and that additional undercutting has occurred since then, as reported by Worischek.

2.3 Operation

There is a minimum of operation at the dam. The spillway is uncontrolled, and the paddle gate openings in the miter-gate of the canal intake are reset at weekly intervals to maintain the water level in the Dundee Canal at a predetermined level, currently 54-inches below the top of the center intake wall. Water entering the Canal is not measured.

2.4 Evaluation

a. Availability

The availability of engineering drawings is inadequate to determine the safety and stability of the dam. There is no complete or detailed set of drawings describing the various key cross sections.

There are no boring logs or foundation profiles available to assess the adequacy of the foundation.

There are no design computations of any kind available for checking.

There is no data to verify the hydrostatic uplift under the dam.

b. Adequacy

The data available is inadequate to properly assess the dam's safety. Recommended data acquisition is described in Section 7.

c. Validity

The validity of existing information is questionable until assembled in a coherent set of record as-built drawings by the owner, to be field checked and surveyed as necessary.

SECTION 3

3. VISUAL INSPECTION

3.1 Findings

a. General

Dundee Lake Dam is in an advanced state of deterioration at the left abutment and at the right abutment canal intake facilities. The main spillway section looks adequate on visual inspection because it is apparently constructed on line and on grade, but available inspection reports reveal that the toe of the spillway is undercut for over one half of its total length. The owner has embarked on a program to improve the safety of the dam and its abutment.

b. Dam

As mentioned above, the spillway crest is smoothly aligned on a long radius horizontal curve and water is flowing over the flat weir crest in a satisfactorily even manner, even though the weir crest is not exactly level according to data taken during the 1936 WPA survey which showed a variance of 1.5 inches in the level of the weir crest. The face of the dam was not available for inspection, but a 1974 report by Worischek states that a manual inspection on the stones shows no undue wear. On the left abutment spillway training wall, the masonry joints are eroded below the level of the spillway crest. On the right abutment, the riverward canal wall was leaking through masonry joints at several places. The area below the reach of river wall, where it has been lowered to provide a side weir for control of water levels in Dundee Canal, is eroded by action of cascading water.

There was no evidence of structural cracking. The left abutment has been partially destroyed or vandalized at the top courses of masonry. The downstream area of the left abutment is severely eroded by drainage

water coming from the adjacent street. Concrete rubble has been dumped over the abutment slope in an attempt to halt the erosion.

Seepage was observed in two areas, 3 to 5 feet in length, above the toe of the left abutment, approximately 12 to 15 feet from the spillway wingwall. The seepage was estimated to be about 1 gpm at the time of the inspection, and the source is believed to be the reservoir.

c. Appurtenant Structures

The canal intake is in an advanced state of deterioration. The miter lock gate on the riverward pass is inoperative in the closed position. The paddle valves, originally meant to equalize water levels on both sides of the miter gate for ease of operation, are still operable and are adjusted to control water levels in the Dundee Canal. The downstream lock gate on this pass has been removed.

The landward pass is blocked by a timber wall which contains four manual operated sluice gates. This timber wall separates the reservoir from the canal. The sluice gates were originally operated by a handwheel and a spur gear reduction drive. All the operating mechanisms have been partially dismantled and the sluice gates have been abandoned, and at one point in the past, were set on fire by vandals in an attempt to burn them down.

These structures (the lock gates and timber wall) should be replaced by a more durable structure, and this new structure should contain facilities for by-pass and emergency reservoir draw-down.

In addition to the above mentioned equipment, there are two sluice gates located in a vandalized gate house on the embankment which separates the canal from the downstream Passaic River channel. These gates are approximately 200 feet downstream of the dam, and were intended to drain water from the canal to the downstream river channel. Again,

these gates have been abandoned and the operators dismantled. However, there is considerable leakage, either through the gates or around the frames. The rehabilitation of this gate structure is considered important since it is the only practical and permanent way to achieve reservoir draw-down in order to permit inspection of the upstream face of Dundee Lake Dam.

Dundee Canal starts at the canal intake and runs southward as described in Section 1.2. An inspection of the canal bank between the intake and Ackerman Avenue, Clifton, did not reveal any seepage or slides. The maximum canal levee height inspected was approximately 10 feet with about a 10-foot minimum crest width. The riverward embankment was at places overgrown with brush and could be better maintained to assure its continued serviceability.

d. Reservoir Area

The shore of the Passaic River constitutes the reservoir rim. The shore in the immediate area of the dam gave no visible signs of instability. In the event that localized sliding or sloughing should occur, it is not felt that such a slide would endanger the safety of the dam.

Visual examination of the dam and reservoir area shows that thin-bedded, fine-grained red sandstone (Brunswick Formation) crops out downstream of both abutments. Thin, less than one inch, laminae of soft red shale occur as interbeds in the sandstone. Jointing in the sandstone is randomly oriented and both parallel and perpendicular to the bedding. Joint surfaces are normally less than 2 feet in length and tight. Just downstream of the left abutment masonry structure, a thin zone, less than one-foot thick, of residual red sand veneers the bedrock. A map of the geologic setting is shown as Drawing 9 (see "Plates" section).

e. Downstream Channel

The downstream river channel is well defined, with moderately steep banks and a shale bottom. There is a small island downstream of the dam which should not affect the tailwater elevation significantly. There are numerous commercial and business establishments along the downstream river banks.

3.2 Evaluation

Visual inspection shows that Dundee Lake Dam is in a deteriorated condition particularly in the following areas:

1. Partially vandalized left masonry abutment that exhibits seepage and has a severely eroded downstream river bank area abutting it.

2. Severely dilapidated canal intake with inoperative and deteriorated timber control gates and bulkheads.

3. Vandalized and inoperative gate house downstream of the canal intake that could be used as a satisfactory low level outlet, if rehabilitated.

4. Spillway structure that is undercut at the toe for over one half of the spillway length according to reports furnished by the owner.

The visual inspection check list is included in Appendix A.

Photographs taken during the site inspection are included in Appendix B.

SECTION 4

4. OPERATIONAL PROCEDURES

4.1 Procedures

There are no formal operating procedures established. The only routine operations being carried out are related to maintenance of the Dundee Canal water level at a predetermined elevation at the intake.

4.2 Maintenance of Dam

No formal maintenance of the dam has apparently been made in the last two decades, but ownership has passed into the hands of the Hackensack Water Company which has started a program of temporary rehabilitation and improvement. The improvement are shown on Drawings 7 and 8 ("Plates" section). Some of the repairs are considered temporary because of uncertainties connected with the relocation of State Route 21, which could utilize the present Dundee Canal as its right of way. The Hackensack Water Company has a policy of conducting an annual on-site inspections of each of its dams, and reports of these visits are prepared by the Chief Engineer and kept in his files.

4.3 Maintenance of Operating Facilities

There has been no significant maintenance of the operating facilities until this year when structural and maintenance type repairs were initiated.

4.4 Description of any Warning System in Effect

There has been no formal warning system established in case of dam failure or malfunction of any of its appurtenances.

4.5 Evaluation

Maintenance and operation of this deteriorated facility has passed into the hands of an experienced staff of a major private water company, resulting in increased inspection, surveillance, and maintenance. The owner should utilize a format similar to the Corps of Engineers' visual check list in making its annual inspection. The canal banks in the reach between the dam and Ackerman Avenue in Clifton should be included in the inspection and the vegetative growth on the canal banks should be controlled from its current wild state. An operating log should be established at water levels and should be recorded in the canal and at the dam crest. At least two redundant communication links should be established between the owner and the police or civil defense authorities in the downstream communities of Garfield, Clifton, Passaic, Wallington and Rutherford, in case of an operating accident, dam failure or expected heavy reservoir inflow during severe storm events.

SECTION 5

5. HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

Dundee Lake Dam impounds approximately 2,584 acre-feet of water in the reservoir at normal storage capacity. The dam is located on the Passaic River which empties into Newark Bay, New Jersey. Its entire watershed area of 810 square miles lies in northeastern New Jersey and southeastern New York. The roughly elliptical shaped basin is bounded on the north and west by the Appalachian Highlands of New York and New Jersey, on the south by the First Watchung Mountains, and on the east by the Piedmont Plain. The watershed is divided into three distinct topographic and hydrologic regions: the Highlands Area, the Central Basin and the Lower Valley. Plate 1 in Appendix D is a watershed map of the Dundee Lake Dam. The Highland Area contains over 600 square miles of the northwesterly portion of the Passaic River Basin. It is a mountainous and heavily wooded section of the Appalachian Mountain Province.

The Central Basin, containing 253 square miles, is a flat oval shaped depression approximately 10-mile wide and 30-mile long, lying between the foot of the easterly slope of the Highland Area and the crescent shaped Watchung Mountains to the south and east.

The Lower Valley, containing 68 square miles of the Passaic River Watershed, lies between Little Falls at the northern edge of the Central Basin and the Dundee Lake Dam.

These three regions of the Passaic River have different flood producing characteristics. The streams from the Highland Area are the greatest flood producers in the Central Basin,although the area contains a large number of natural and artificial lakes and reservoirs. During periods of flood, the flood plain in the Central Basin acts as a natural detention reservoir which materially retards the peak and reduces the flood intensities below Little Falls in the Lower Valley.

The evaluation of the hydraulic and hydrologic features of the Dundee Lake Dam was based on criteria set forth in the OCE Guidelines and additional guidance provided by the Philadelphia District, Corps of Engineers for determining the Probable Maximum Flood (PMF). Hydrologic and hydraulic data from the owner were not available for assessment of its adequacy and accuracy. However, the New York District, Corps of Engineers has published Probable Maximum Flood Values and PMF Hydrographs for most of the key locations on the Passaic River Basin in the report, "Passaic River Basin - New Jersey and New York, Survey Report for Water Resources", dated June 1972.

From the Passaic River Basin, Survey Report, the PMF has the following characteristics:

Peak discharge	88,100 cfs
Time to Peak (measured from start of rainfall)	84 hours
Runoff under the PMF hydrograph	14.41 inches

The shape of the PMF hydrograph was patterned according to the PMF hydrograph of Beatties Dam Outflow from the Central Basin plus flow between Two Bridges and Beatties Dam shown on Figure A64 of the same report. The PMF hydrograph for the Dundee Lake Dam is shown on Figure 2 of Appendix D.

The PMF and the one half PMF inflow hydrographs were routed through the reservoir by the Modified Puls Method utilizing computer program HEC-1. The peak outflow discharge for the PMF and one half of the PMF are 87,772 cfs and 43,887 cfs respectively. The PMF results in overtopping of the dam, but one-half of the PMF can be passed without overtopping.

The stage-outflow relation for the Dundee Lake spillway was based upon the available information on elevations and dimensions on the plans acquired during the data assembly phase. Discharge through the outlet works was excluded from the foreseeable future. The reservoir stage-capacity curve above spillway crest was obtained by planimetering U.S.G.S. 7.5 inch quadrangle sheets. The spillway rating curve and the reservoir stage-capacity curve are shown in Figures 3 and 4 respectively, of Appendix D.

b. Experience Data

There are at present 20 active recording stream gaging stations in the Passaic River Basin, three on the main stream and 17 on the tributaries. The stations in the basin have records varying in length of time from 8 to 66 years. The records of these stations are published in the Water Supply Papers of the U.S. Geological Survey, North Atlantic Slope Basins.

The flood of October 1903 was the maximum of record in the Passaic River Watershed. The beginning of the sudden flood rise was almost simultaneous on all branches of the Passaic River at approximately 6:00 p.m. on Thursday, October 8, 1903. This storm was one of the worst in the vicinity of the Passaic River Watershed, occurring after a period of three months of excessive rainfall which has saturated the ground and raised ground water levels throughout the Passaic River Basin. The peak discharges on the Passaic River were 31,700 cfs at Little Falls and 35,800 cfs at Dundee Lake Dam. The total volume of runoff at Dundee Lake Dam was 6.50 inches. During this flood, the flood level was approximately 91.5 inches over the spillway crest, but no significant damage was recorded from the high head over the spillway crest.

A comparison of flood data of maximum floods or record on the Passaic River Basin taken from the "Passaic River Basin - New Jersey and New New York - Survey Report for Water Resources" dated June 1972 by the New York District Corps of Engineers, is presented on Plate 5 of Appendix D.

c. Visual Observations

The Passaic River channel downstream of the Dundee Lake Dam looked stable. Large trees are growing on an island in the middle of the downstream river channel. There was no evidence of overtopping of the dam at any time.

d. Overtopping Potential

The PMF, when routed through the Dundee Lake Reservoir, results in overtopping the dam by 3.10 feet. However, the spillway is capable of passing a flood equal to 56 percent of the PMF without overtopping the dam. Since

the PMF is an extremely rate event, the overtopping potential of the dam is minimal. Nevertheless, the spillway capacity of the Dundee Lake Dam is considered inadequate since a flood magnitude equaling the PMF cannot be passed without overtopping.

e. Reservoir Drawdown

At present, reservoir drawdown is not possible because the low level outlet gate house is in ruin and inoperable. Computations have been made on a hypothetical basis assuming a rehabilitated gate house, even though the owner has made plans to permanently block off this facility.

The reservoir drawdown below the spillway crest, elevation 25.40 could be accomplished by permitting discharge through a rehabilitated gate house and into the diversion channel with invert elevation 11.09. The minimum tailwater corresponds to elevation 12.10 resulting in a total head differential of 13.40 feet. Assuming a constant inflow of 1,620 cfs (2 cfs/sq.mi.), the total drawdown time would be 44 hours, at which point the inflow equals the outflow and the reservoir pool is at elevation 15.0 ft. Assuming zero inflow the drawdown to elevation 12.10 could be accomplished in 20 hours, if the gate house were to be made operational.

SECTION 6

6. STRUCTURE STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

Visual observations have been recorded in Section 3.1 - b. , and the facilities' deficiencies are listed in Section 2.4. Visual signs casting doubts on the stability and strength of the structure and its appurtenances are noted as follows:

1. Seepage daylighting under the left abutment wall.

2. Severe bank erosion downstream of the left abutment.

3. Eroded masonry joints in the left abutment spillway wingwall.

4. Leaking joints in the river wall of the canal intake.

5. An eroded area at the base of the river canal, where discharges from the side weir cut into the wall impinge on the foundation rock.

6. Previously discovered undercutting of the spillway masonry at the toe, reported independently by the owner's survey in 1974, could not be inspected since it was below water at the time of inspection.

On the positive side, the structure has survived 120 years of service in spite of being neglected, and partly vandalized. The maintenance and repairs currently being undertaken only address themselves to the most urgent safety deficiencies and are considered a welcome first step after years of neglect by the previous owner.

b. Design and Construction Data

Not enough data has been assembled to allow a definitive stability analysis to be carried out. There is too much uncertainty as to the actual height of the dam, the rock formations underlying it and the properties of the fill sloped against the back face of the masonry section. These factors also do not permit an evaluation of the proper uplift forces to be considered under the dam which are needed to complete the stability analysis. A tailwater rating curve would also be required for proper evaluation of stability factors.

It is not definitely known why the downstream masonry height of the dam is greater (17-20 feet) than the upstream height (13 feet). The most plausible explanation is that the structure was repaired after the 1870 Lindsley report according to his suggestions and methodology, but has been further undercut in the 90 to 100 intervening years. Mr. Worischek's alternate explanation, given in full in Section 2.2, cannot be ruled out in the absence of any data that indicates that Lindsley's suggested repairs were actually carried out.

Preliminary stability calculations made in connection with this phase shows that the stability of the spillway section is questionable for all overflow depths greater than 4 feet unless the conventional uplift assumptions of 100 percent head and tailwater pressures applied over 100 percent of the base area are modified. The rationale for such a modification would be the effect of the sloping backfill placed behind the spillway masonry which would reduce the head water hydrostatic uplift pressure at the heel. This possible reduction in uplift should be checked further as part of a continuing investigation.

c. Operating Records

There are no operating records which have a bearing on the stability of the dam except for the previously cited Lindsley and Worischek reports, and the fact that the dam passed the 1903 flood with little or no damage.

d. Post Construction Changes

As described above, it is believed that the downstream face of the stepped spillway has been extended downstream to meet the eroded rock level some time after 1870. In 1978, the owner instituted a planned program of repairs according to the designs shown on Drawings 7 and 8 appended.

The program consists of the following:

1. Rebuilding of the left abutment to its original shape. This will improve the stability and safety of the structure.

2. Filling of the undercut parts of the foundation rock at the downstream toe of the spillway. This repair will improve and safeguard the stability of the spillway section and halt a possible piece-meal destruction of the spillway toe.

3. Repair of the area below the side spillway of the river wall of the canal intake. This repair will halt erosion and deterioration and safeguard the stability and safety of the river wall.

4. Repair of the timber bulkhead wall by adding new walers and a walkway between the right shore and the river wall of the canal intake. This repair does not address itself to the structural integrity of the timber bulkhead and closure gates on the landward pass of the canal intake or the timber miter gate controlling the riverward pass. It does improve access to the river wall and permits safer operation and maintenance of the paddle gates mounted on the miter gate.

5. Addition of a steel sheet pile cut-off wall on the river face of the Dundee Canal extending from the end of the river wall passing in front of the gate house, and tying it to an existing sheet pile cell previously installed in connection with a pipe crossing project. The gate house would be razed and abandoned. This repair would improve the stability of the canal bank but is considered objectionable because it cuts off the gate house and any possibility of lowering the reservoir pool behind Dundee Lake Dam during low flows. It would be better, in the opinion of the dam inspection team, to redevelop the gate house as a low level and emergency outlet so that it would be possible to inspect the dam's face in the dry during the river's annual low flow period in the late summer and early fall.

e. Seismic Stability

In general, projects located in Seismic Zone 0, 1 and 2 may be assumed to present no hazard from earthquake, provided that static stability conditions are satisfactory and conventional safety margins exist.

SECTION 7

7. ASSESSMENT / REMEDIAL MEASURES

7.1 Dam Assessment

a. Safety

The dam has been inspected visually and a review has been made of the available engineering data. This assessment is subject to the limitations inherent in the visual inspection procedures stipulated by the Corps of Engineers for Phase I Report.

The dam safety is in question since it cannot pass the full PMF without overtopping. It can, however, pass 57 percent of the PMF or more than one half of the PMF without overtopping.

The spillway's stability is in question at high discharges. Proper evaluation of this stability would require additional data on the dam configuration, dam heights at the toe and heel, a downstream tailwater rating curve, and an analysis of the effect of the upstream fill on the uplift and seepage forces under the dam.

The dam's low level outlet gate house in the intake canal bank is inoperative and work is underway to permanently block off the gate house and raze it. Absence of such a facility is considered detrimental to the safe maintenance of the spillway.

b. Adequacy of Information

Present information is inadequate to determine safety. Required additional information includes:

1. Assemblage of all dam information into a coherent self contained set of drawings depicting the present condition of the dam. Additional surveys will be required to complete the information needed. A detailed survey of the bulkheads and gates at the canal intake is also required.

2. A wash and core boring program at the abutments and along the dam axis to determine the quality and engineering properties of the foundation material and the dam/foundation interface at the heel of the spillway and under both abutment core walls.

3. An analysis of the fill material behind the dam to determine its permeability and engineering properties.

4. An analysis of piezometric levels existing at the dam/masonry interface and in the foundation down to a place 20 feet below the spillway crest, needed for determining uplift forces in the stability analysis of the spillway.

5. Monitoring of seepage under the left abutment, and correlation of seepage volumes with reservoir levels.

c. Urgency

This includes the following:

1. Data required in Section 7.1-b. should be acquired within an 12-month period.

2. Studies to increase the spillway capacity should be completed within one calendar year.

3. Studies to rehabilitate the existing gate house or provide a new low level outlet facility should be completed within one calendar year.

4. Stability studies on the spillway section should be completed within 2 months after basic data becomes available.

5. Studies for the structural adequacy of the timber, bulkhead and miter gate should be completed in conjunction with the spillway stability analyses.

d. Necessity for Additional Investigations

On the basis of the findings presented above, additional studies are clearly indicated and required.

7.2 Remedial Measures

a. Alternatives

- Spillway capacity increases can be developed by:

1. Raising the spillway abutment walls, thus providing greater head and discharges over the spillway crest.

2. Adding a new gated spillway section or bottom outlet with appropriate energy dissipating structure.

- The low level outlet can be developed at the present canal gate house site, or at some other convenient location along the spillway or canal river wall.

- The timber bulkhead and miter gate, if found unsuitable for further use can be replaced in kind or replaced with another adequate intake design for the safe control of water supply into the Dundee Canal.

- The area downstream of the left abutment should be regraded and protected against erosion and slope instability. Adequate provisions should be made to safely control surface run-off from the adjacent street, River Drive in Garfield, New Jersey. This work can be reasonably completed within a 6-month period.

- Repoint eroded joints in masonry on left and right abutments. This work can be reasonably completed over a 12-month period.

b. O & M Procedures

The owner should upgrade his O & M procedure by issuing a manual and check list for recommended procedures. The inspection and maintenance visits should be logged and documented. Communication channels should be opened and maintained between the owner and civil authorities in the downstream communities of Clifton, Garfield, Passaic and Wallington in case of accident, high reservoir inflow conditions or a dam operating failure causing high water stages downstream.

The civil authorities should develop and maintain flood preparedness plans to provide warning, evacuation and other assistance as deemed necessary to protect their populations in the event of flooding caused by this structure. Guidance on development of such plans is available from the National Weather Service and others.

The seepage on the left abutment should be monitored and logged.

The Dundee Canal bank vegetative growth should be controlled down to Ackerman Street.

Head and tailwater gages should be installed and routinely read at maintenance visits.

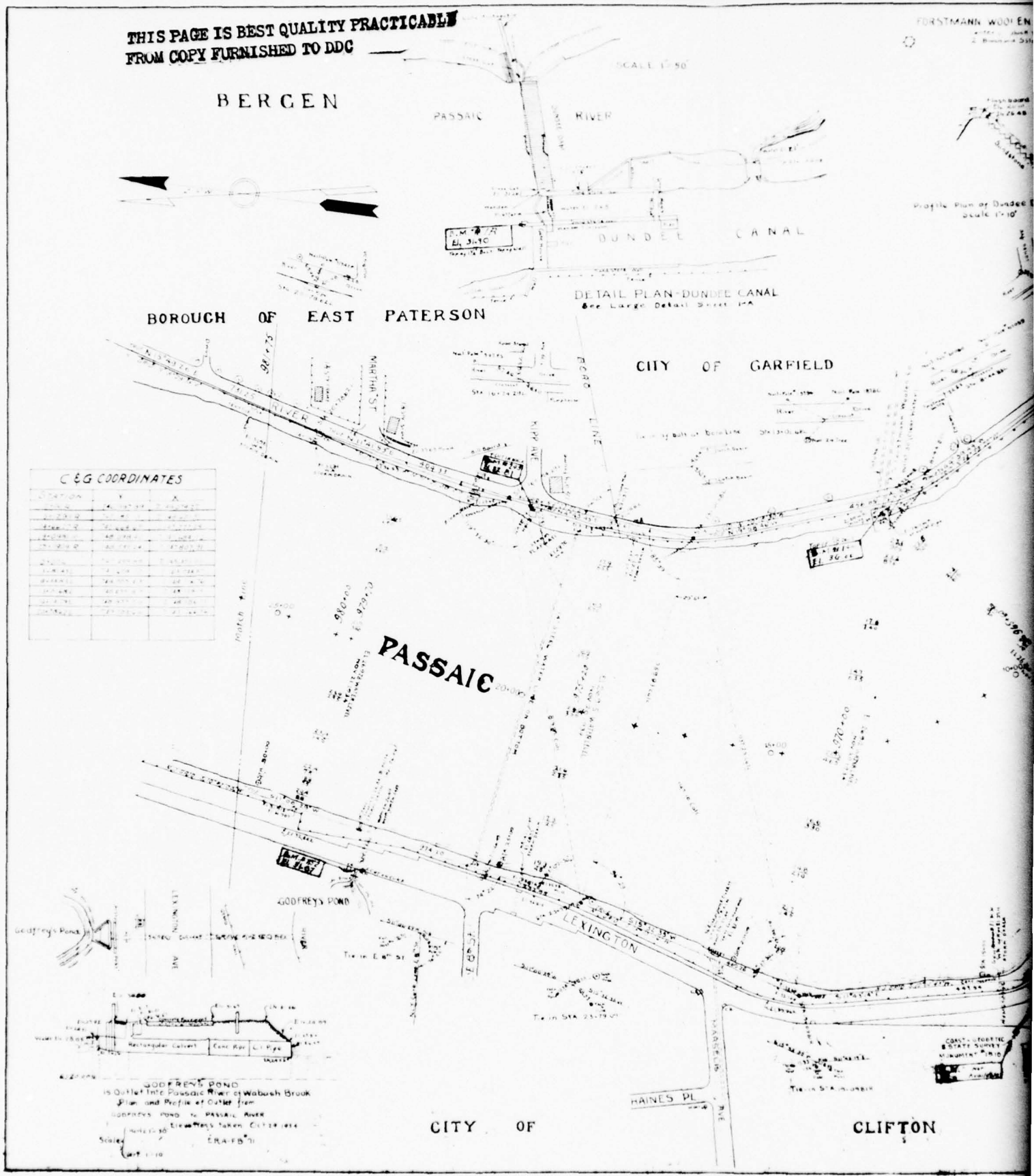
A program should be developed for inspection of the downstream face of the spillway in the dry after the low level outlet is operational, or else by blocking of sections of the spillway crest during the annual low flow period. The first inspection should be carried out within 3 years.

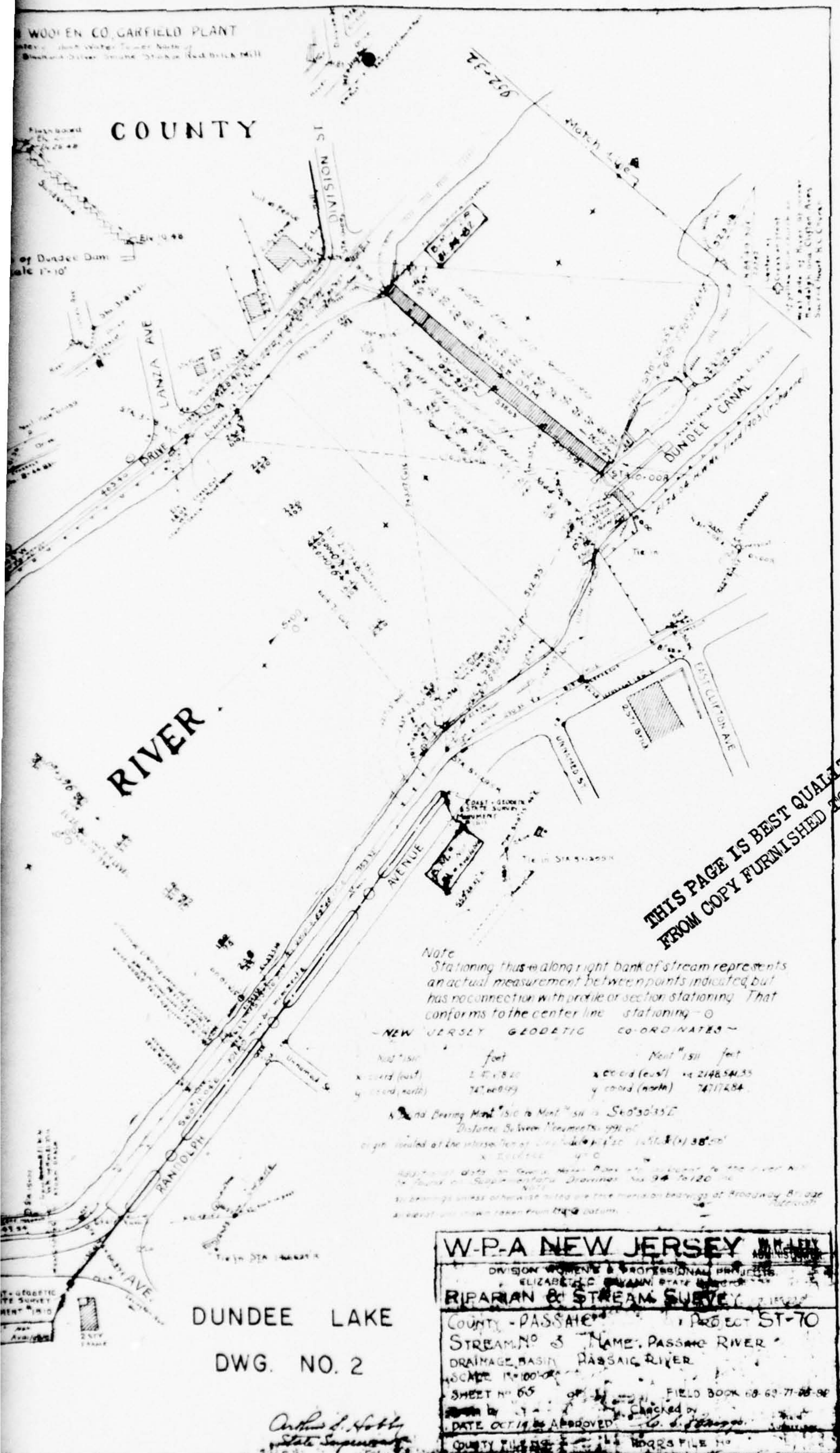
The downstream toe of the spillway should be reexamined at 10-year intervals for signs of further undercutting, and sooner if exceptionally large flood events occur.

PLATES

VICINITY MAP

DWG. NO. 1





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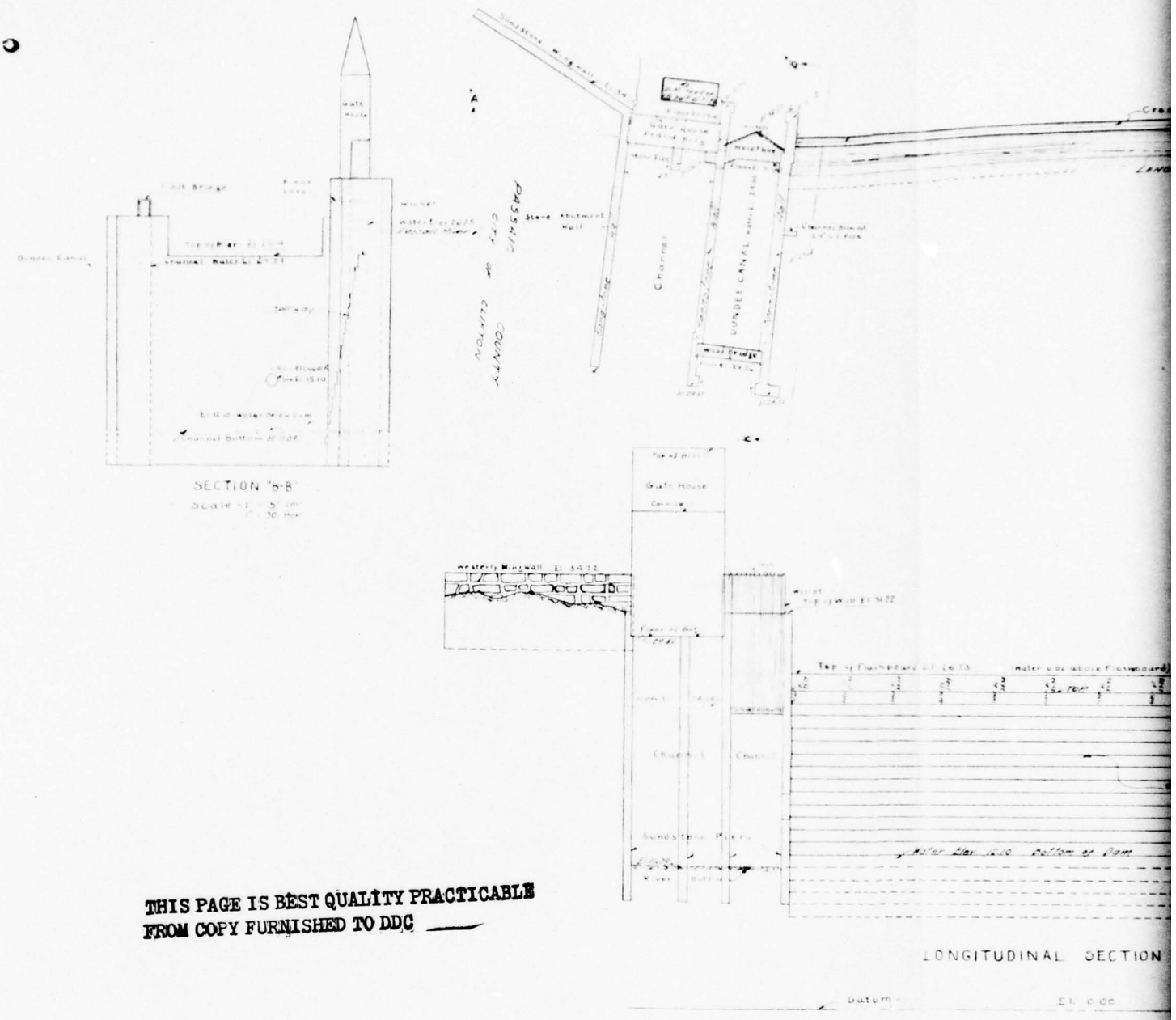
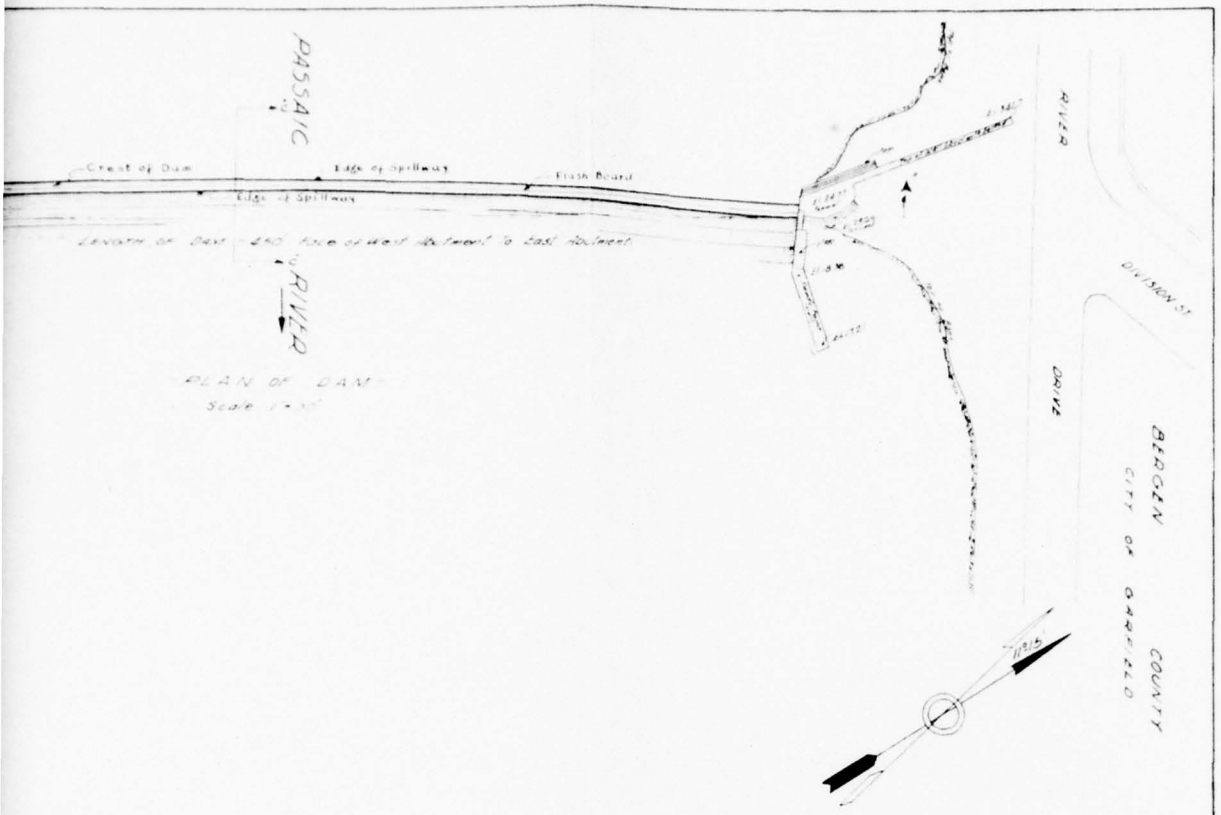


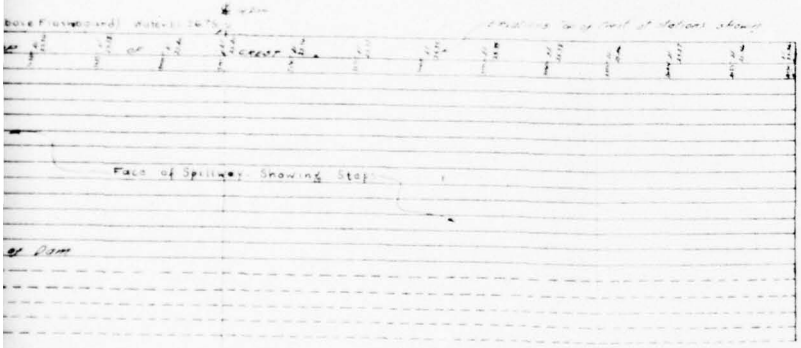
- PLAN OF DUNDEE DAM -

SHOWING

STRUCTURES - SECTIONS & ELEVATIONS



PLAN OF DAM
Scale 1" = 50'



SECTION OF DAM — SECTION "A-A"
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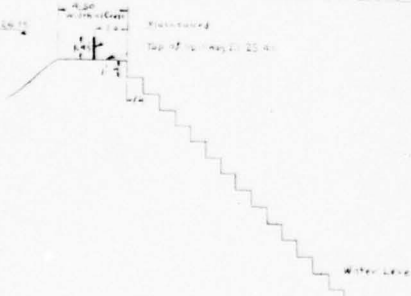


SECTION "C-C"
Scale - 1" = 5'
Hor. and Ver.

NOTE:
ALL ELEVATIONS SHOWN TAKEN FROM N.G.S. DATUM.
ALL ELEVATIONS ARE AS OF SEPT. 6 1936.
SURVEY MADE SEPT. 1936.

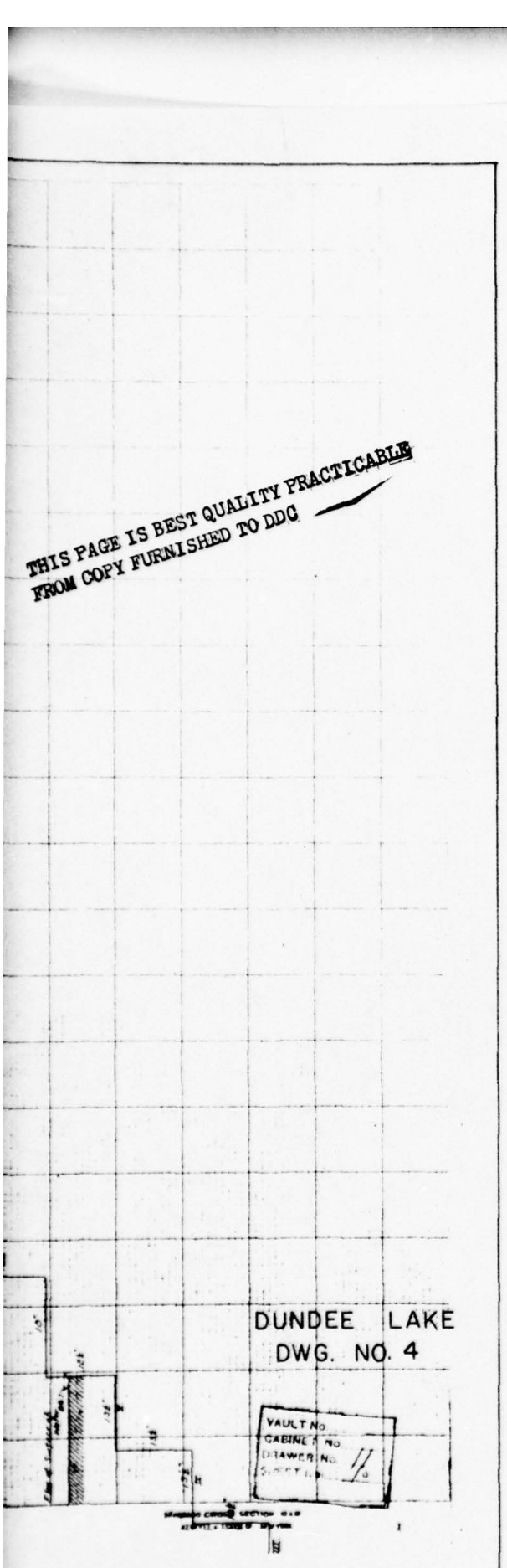
DUNDEE LAKE
DWG. NO. 3

W-P-A NEW JERSEY — W. H. / ELY ADMINISTRATOR
DIVISION WOMEN'S & PROFESSIONAL PROJECTS
ELIZABETH C. D. VANN, STATE DIRECTOR
RIPARIAN & STREAM SURVEY — OP. 165-32-69-1

COUNTY PASSAIC — PROJECT 10187
STREAM NAME PASSAIC RIVER — NO 3
DRAINAGE BASIN PASSAIC RIVER
SCALE AS SHOWN
SHEET NO. 1 of 1 — FIELD BOOK 77-94
DRAWN BY M.N. CHECKED
DATE Sept. 1936
COUNTY FILE NO. — FILE NO.

PROFILE
OF
DOWN STREAM FACE
OF
DUNDEE DAM

DUNDEE LAKE
DWG. NO. 4



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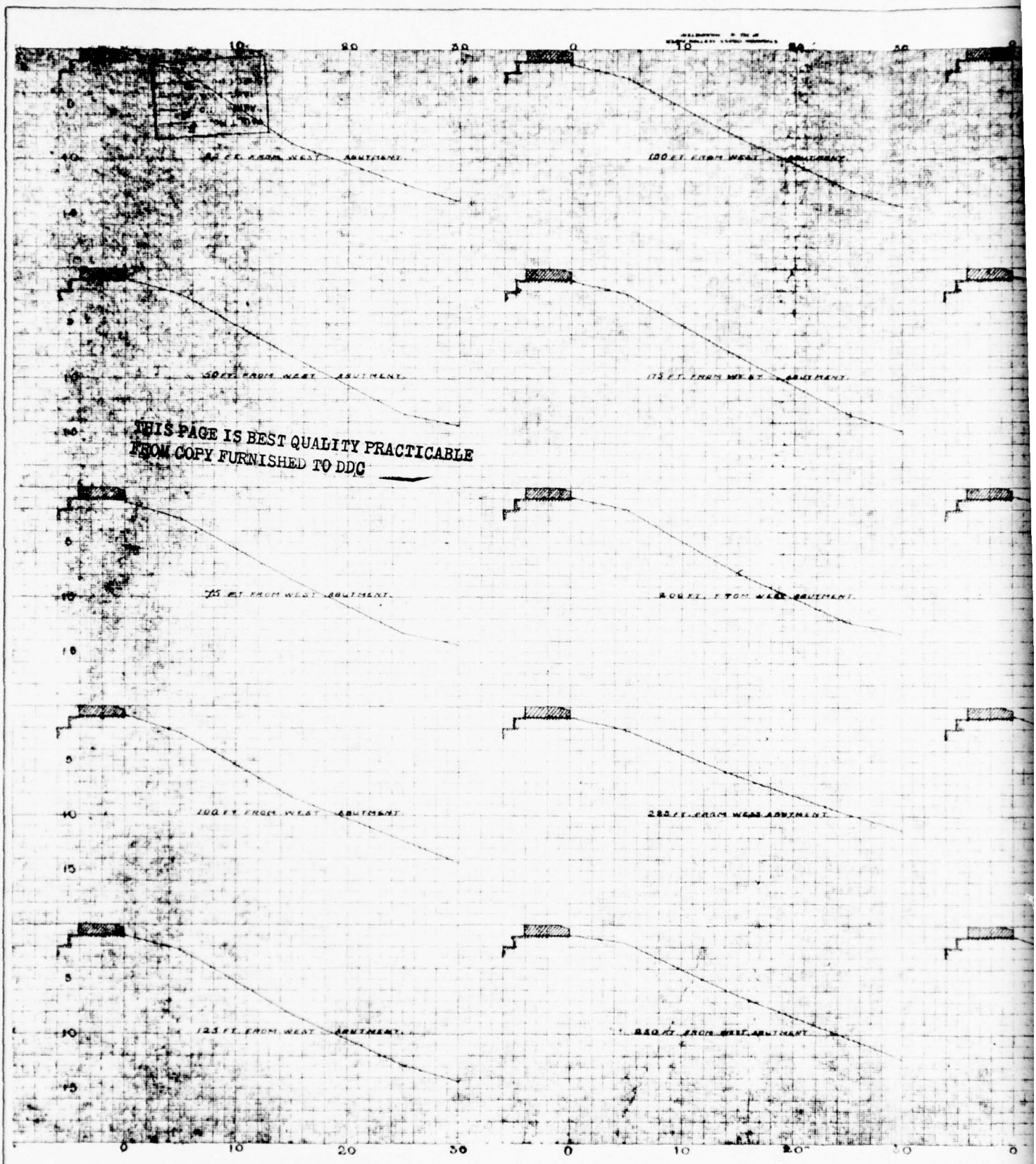
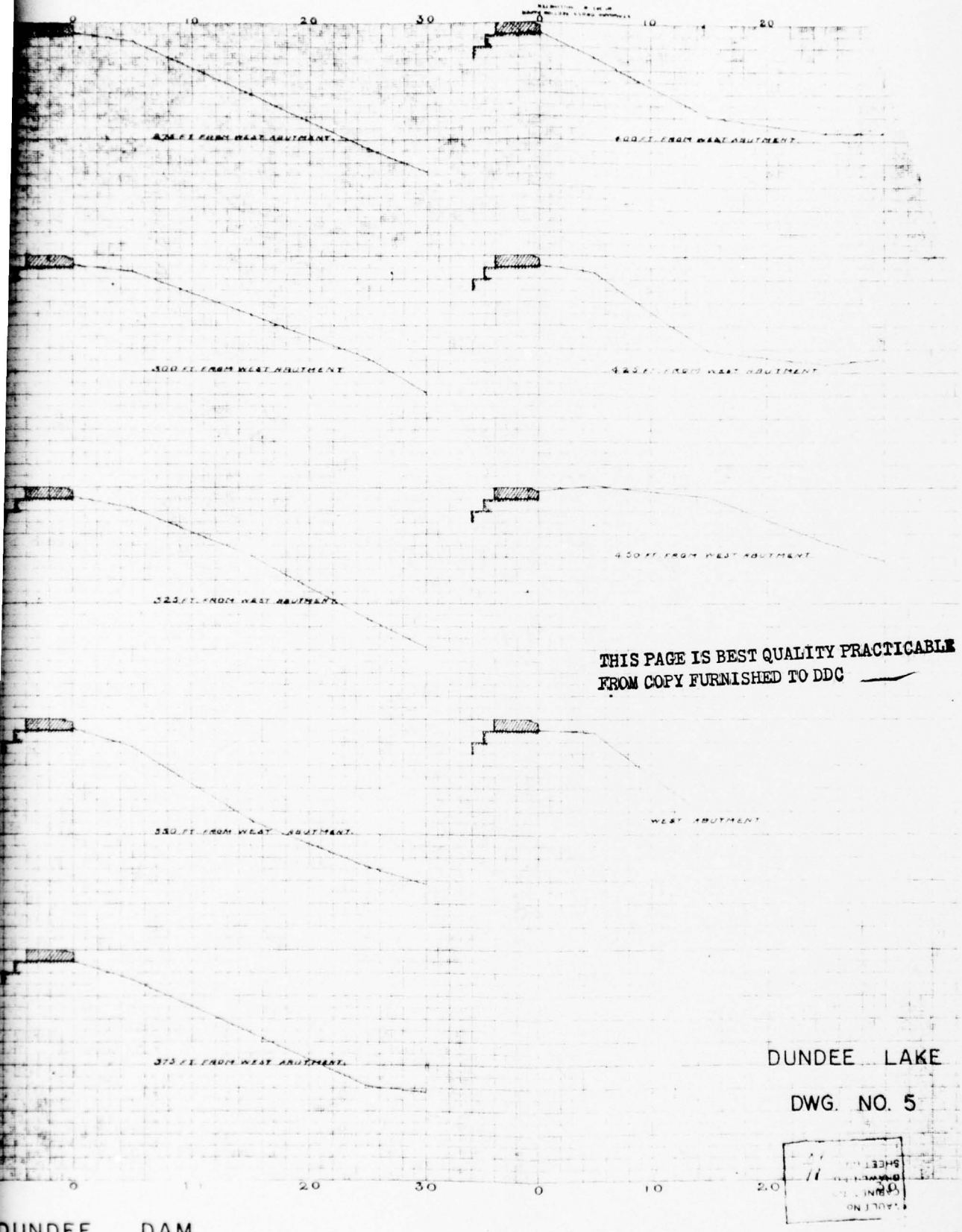


SECTION THROUGH THE DUNDEE

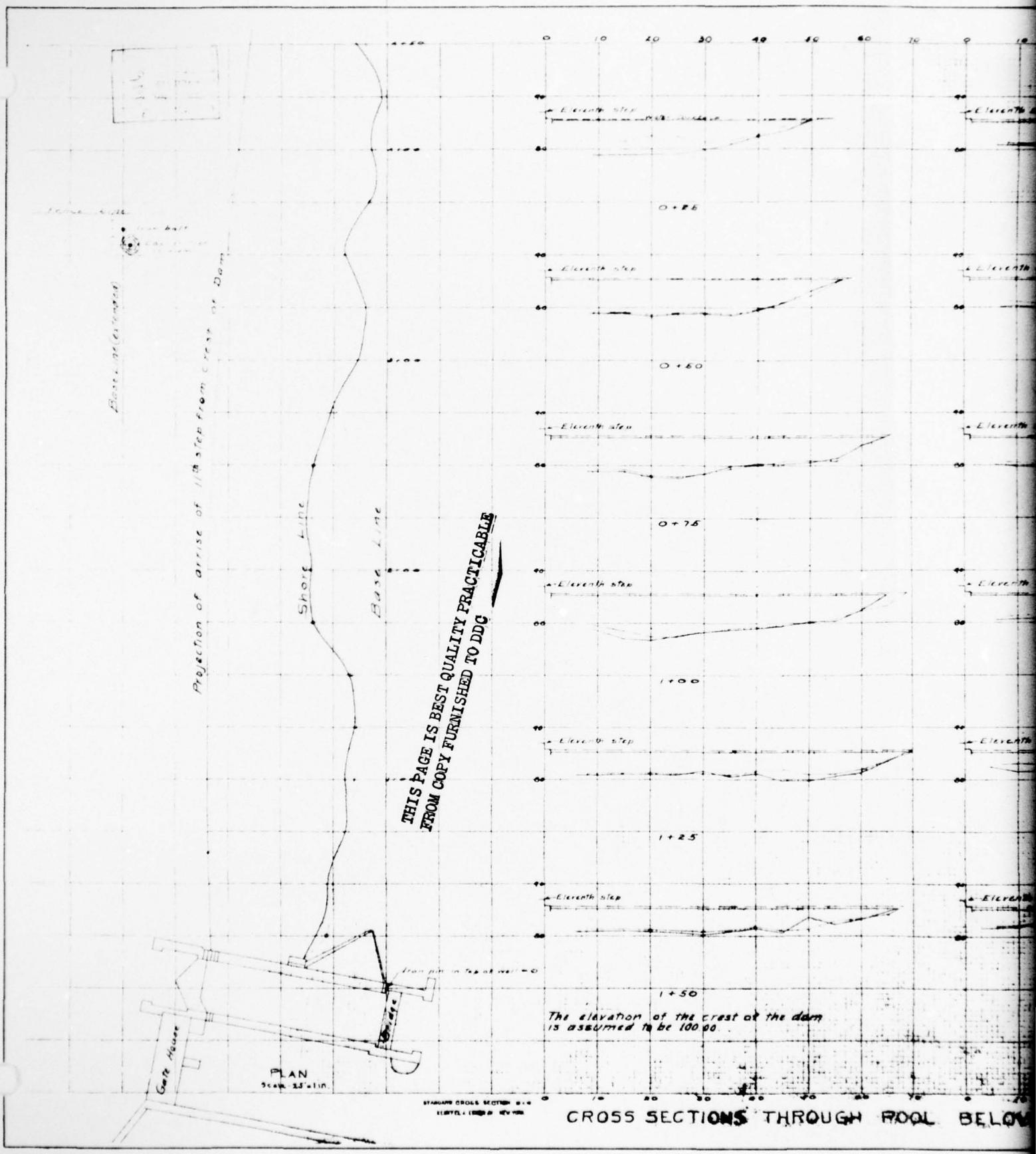


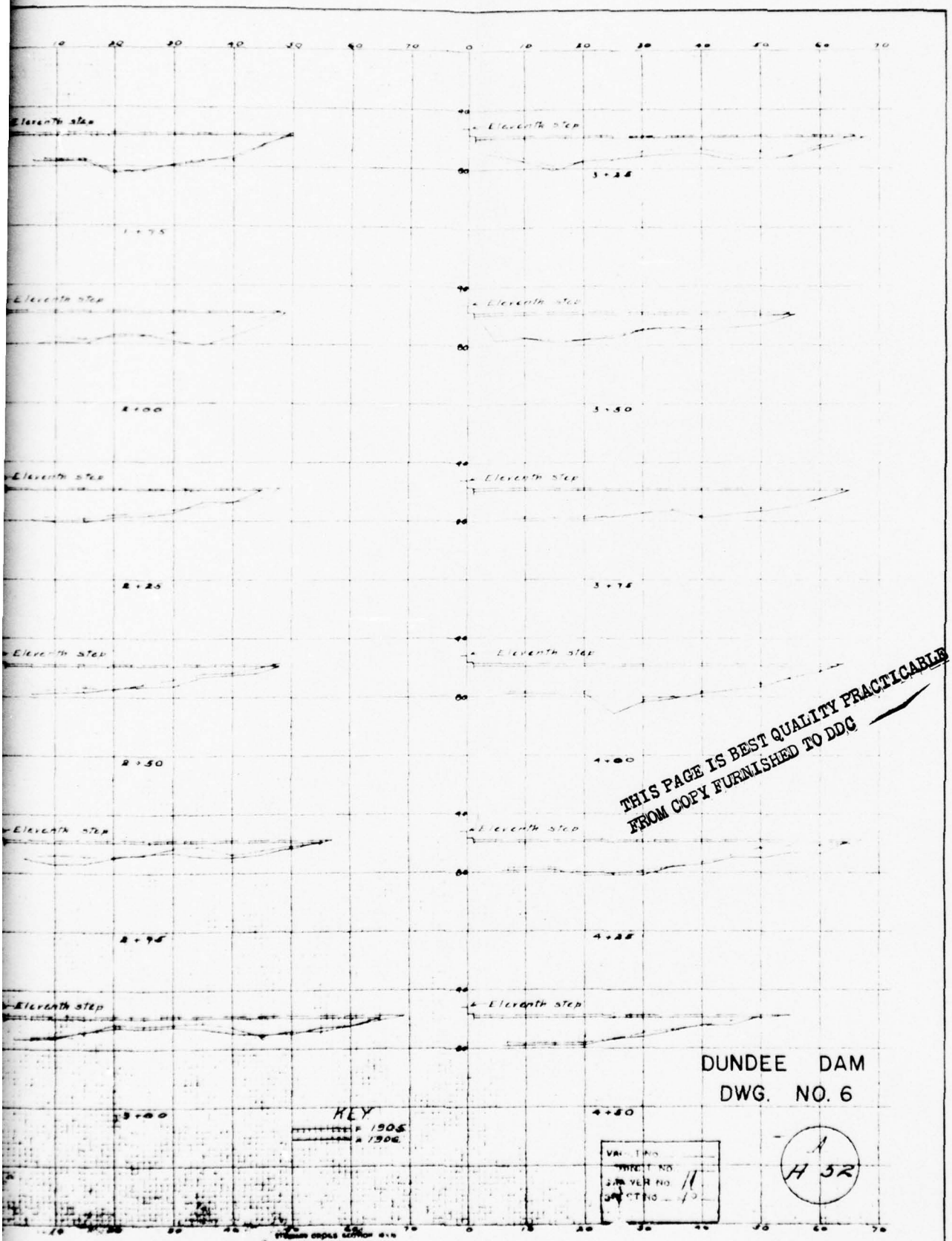
DUNDEE LAKE

DWG. NO. 5

DUNDEE DAM

2





ELOW DUNDEE DAM

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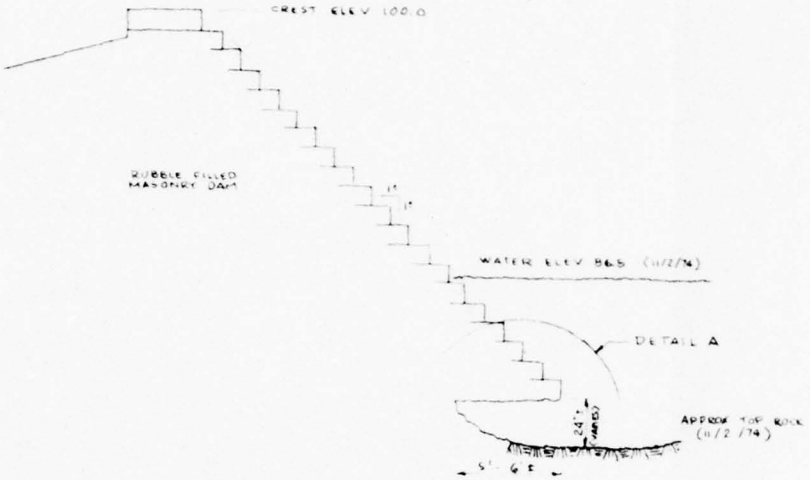
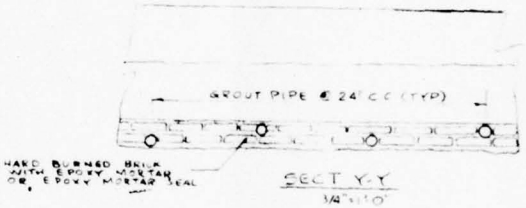


SECT A-A
STA 0+15 E TO STA 0+35 E
1/4" = 1'-0"

Notes
FOR SECT A-A & C



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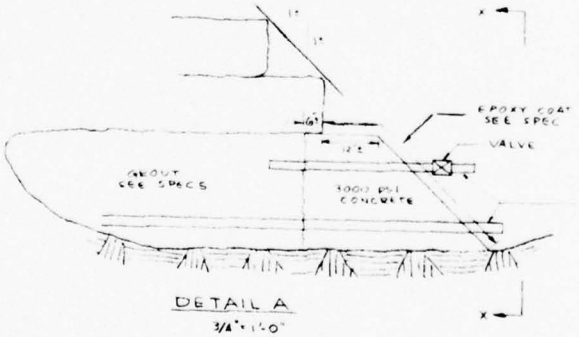
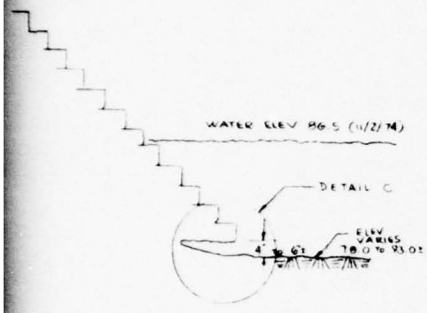


DETAIL A
3/4"=1'-0"

SECT X-X
1/4"=1'-0"

AA & C-C SEE PLATE I-10/3/74 IN SPEC



SECT C-C
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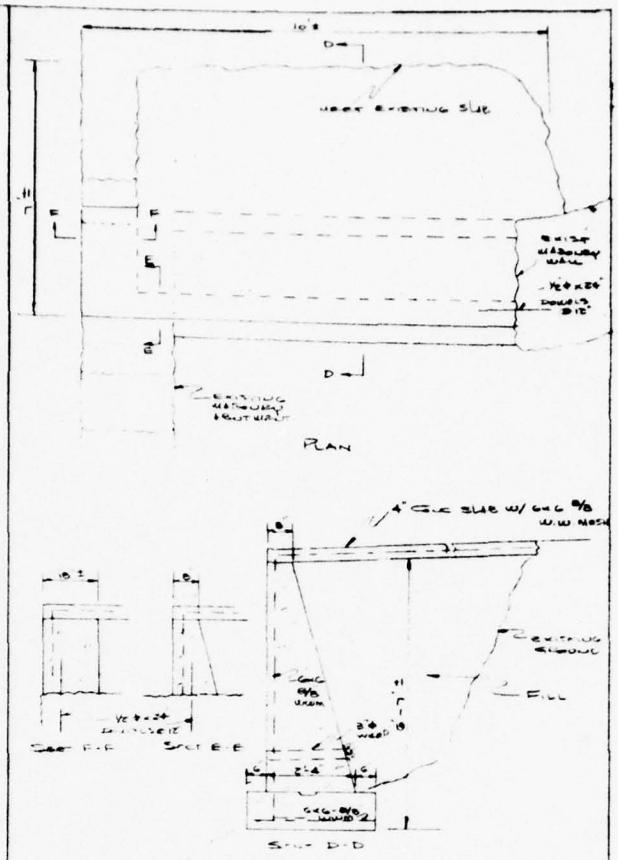
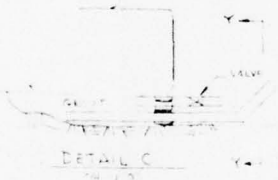


TEMPORARY REPAIR EAST ABUTMENT



T X-X
1"=1'-0"

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DWG. NO. 7.

REV	DATE	BY	REMARKS

DUNDEE WATER, POWER, AND LAND COMPANY

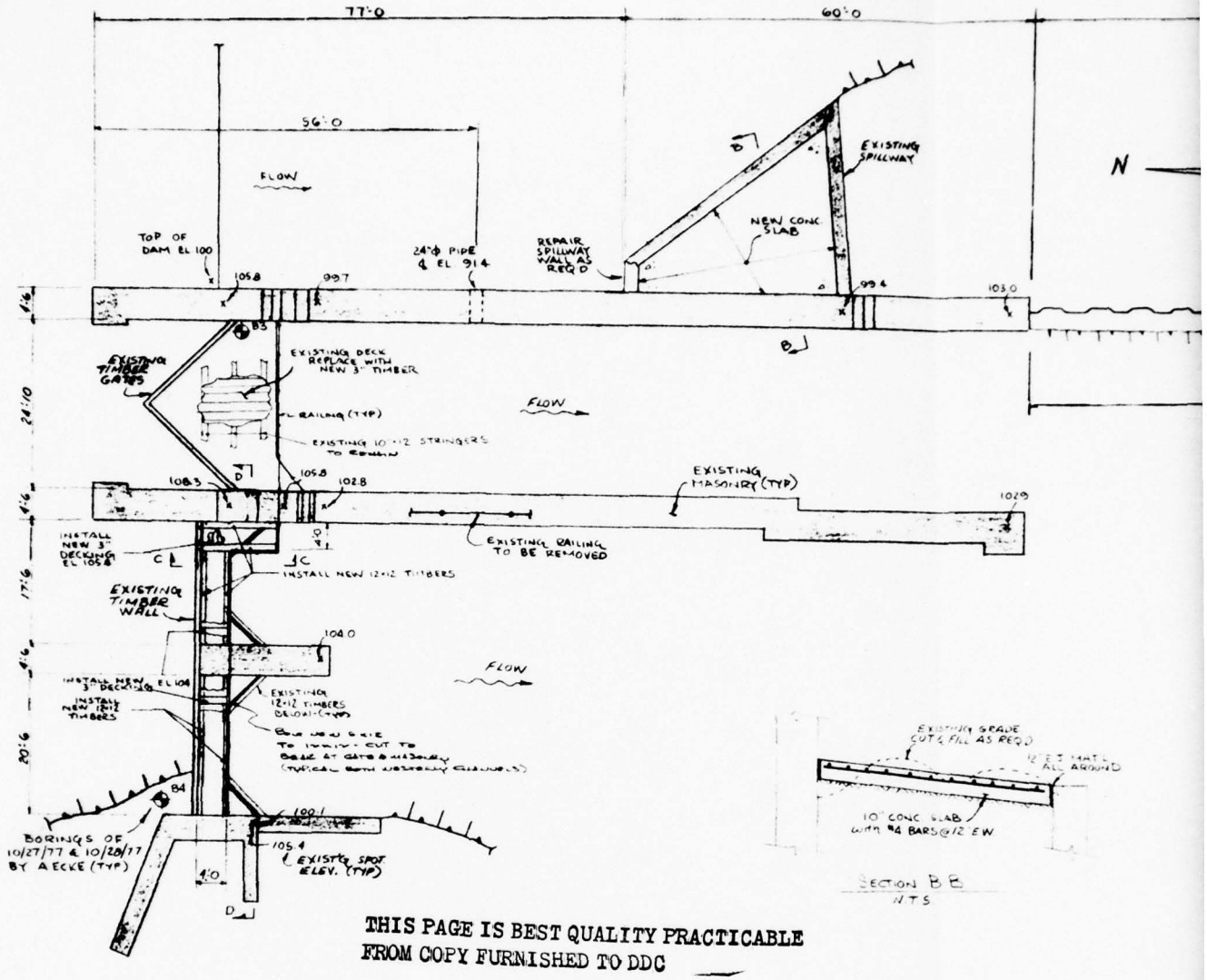
REHABILITATION OF DUNDEE DAM

C WORISCHECK - ENGINEER
NJPE LIC- 11311 CLIFTON, N.J.

DATE 4/17/75 DWG NO 1
DWN BY SHEET
CHKD BY SCALE - As Noted

THE GAULT & FINKELSTEIN CORP

2



SECTION B-E
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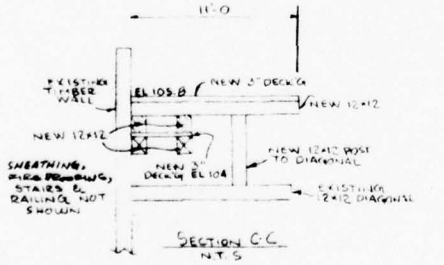

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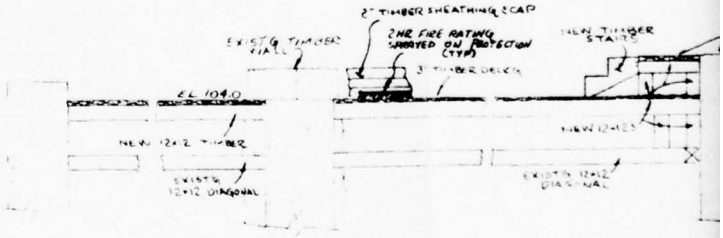

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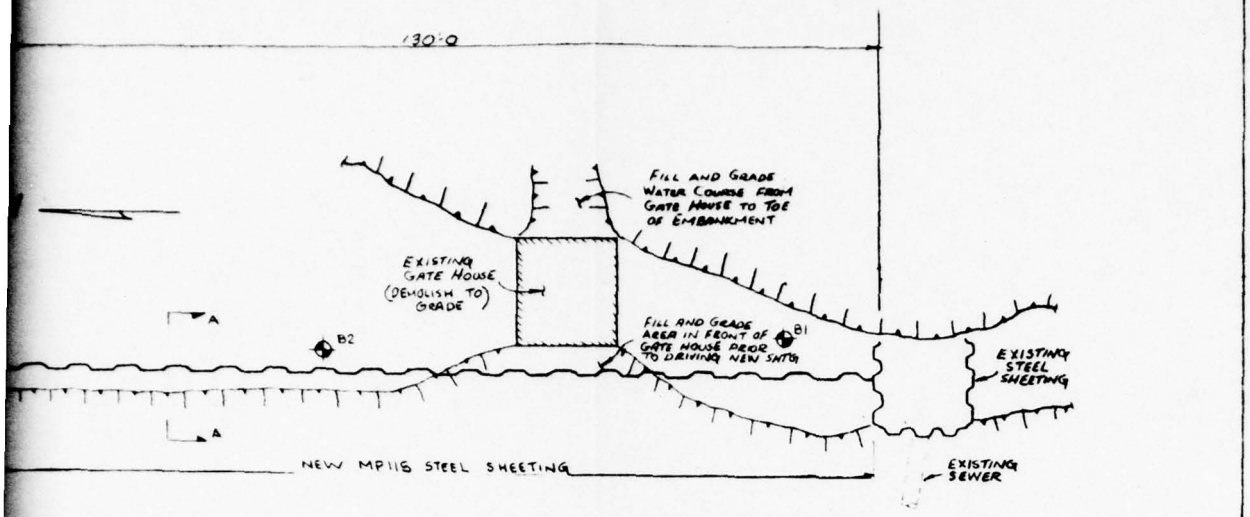
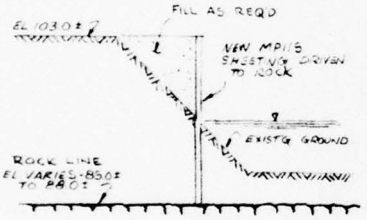
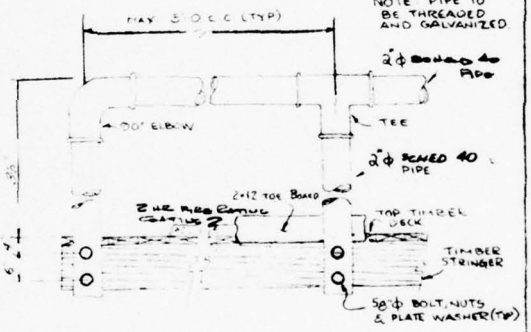
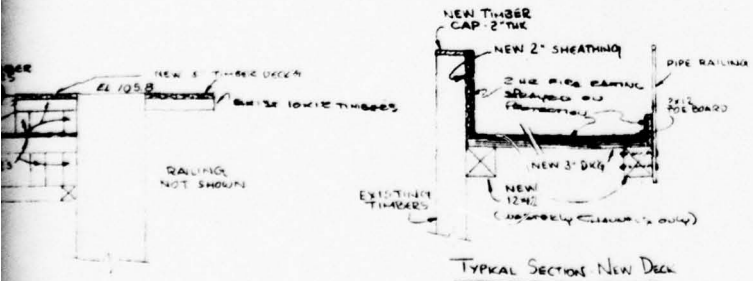




SECTION A-A
N T S



TYPICAL RAILING DETAIL
N T S



TYPICAL SECTION NEW DECK
N.T.S.

DWG. NO. 8

REV	DATE	BY	REMARKS

DUNDEE WATER, POWER, AND LAND COMPANY

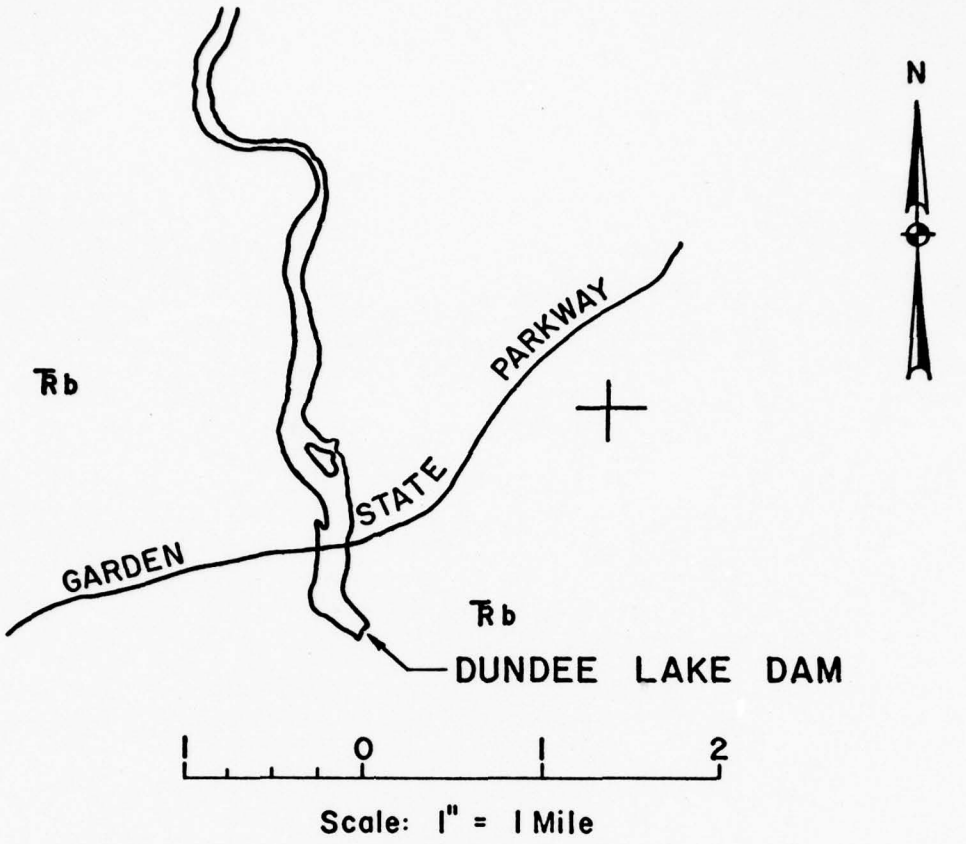
REHABILITATION OF DUNDEE CANAL DIKE AND HEADWORKS

C WORISCHECK - ENGINEER
NJPE LIC - 11311
CLIFTON, N.J.

DATE 4-17-78
DWN BY SL
CHKD BY

DWG NO 1
SHEET
SCALE 1"=10' U.N.

2



Scale: 1" = 1 Mile

LEGEND

TERTIARY

Rb Brunswick Formation
Soft, Red Shale with Interbeds of Red Sandstone

NOTE: Glacial - Fluvial Sands and Gravels Mantling the Terraces Adjacent to the Passaic River not Shown

GEOLOGIC MAP
DUNDEE LAKE

DWG. NO. 9

APPENDIX A

CHECK LIST - VISUAL OBSERVATIONS

CHECK LIST - ENGINEERING, CONSTRUCTION MAINTENANCE DATA

CHECK LIST
VISUAL INSPECTION
PHASE 1

Name Dam DUNDEE LAKE DAM County Bergen State New Jersey Coordinators

Date(s) Inspection	Weather	Temperature
May 3, 1978	Sunny, Fair	65°F
May 5, 1978	Raining	50°F
May 6, 1978	Raining	55°F

Approximately:
Pool Elevation at Time of Inspection 25.9 M.S.L. Tailwater at Time of Inspection 14.5 M.S.L.

Inspection Personnel:

Seymour M. Roth, May 3 and 5
David Kerkes, May 3, 5 and 6
William Flynn, May 5
Yin Au-Yeung, May 5
Lynn Brown, May 6
Larry Woscyna, NJ-DEP, May 5

Recorder: Seymour M. Roth

Owner: Hackensack Water Company - Representatives: (on May 5, 1978)
Mr. James Butler
Mr. Thomas McKeon

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SEE PAGE ON LEAKAGE	Left Abutment: Several spots on land side of and adjacent to spillway wingwall 3-5 ft. wide, approximate leakage 1 gpm. Right Bank: Leakage observed through the masonry river wall forming the canal intake. Leakage observed through defective canal emptying gate.	Correct by regrading and protecting entire left abutment area downstream of dam axis. Determine origin and monitor flow volume. Restore gate facility to operating condition.
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Left abutment: The abutment masonry is in disrepair, partially vandalized. There has been an attempt to fill bank erosion downstream of dam axis caused by adjacent street and surface storm run-off with concrete rubble. Right Abutment: No adverse conditions visible.	Rebuild left abutment wall. Regrade, fill and protect bank area downstream of the dam axis. Provide channels for street storm run-off waters.
DRAINS	One 4-inch diameter drain adjacent to gate house undetermined origin leaking 5 gpm into river.	
WATER PASSAGES	There are no water passages in the masonry weir structure.	
FOUNDATIONS	The dam is founded on massive ledge rock, sand stone with narrow bands of silt and clay seams, horizontally bedded. According to investigations, the dam is undercut at or near the canal intake, and for entire left half of spillway.	Repair under cut dam section.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	The masonry joints in the left abutment spillway wingwall below the spillway crest level are eroded, but in fair condition above that level. On the right abutment, the river ward intake canal pass wall joints are leaking excessively in places, and moderately in others.	Point all eroded masonry joints.
STRUCTURAL CRACKING	No major cracks are visible because of jointed masonry construction. Six inches of water was flowing over the crest obscuring the stepped downstream face.	Owner to inspect downstream face of dam and document with photographs at low water flows. Canal outlet should be restored to permit draw-down of pool below crest.
VERTICAL & HORIZONTAL ALIGNMENT	The vertical alignment of the masonry crest is good to excellent for this 120-year old structure. The flow over the spillway is smooth and apparently fairly even. The horizontal alignment of the crest is smooth along a continuous long radius curve.	
MONOLITH JOINTS	None observed (Masonry block construction)	
CONSTRUCTION JOINTS	None observed (Masonry block construction)	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	NA	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	NA	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	NA	
VERTICAL & HORIZONTAL ALIGNMENT OF THE CREST	NA	
RIPRAP FAILURES	NA	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	NA	
ANY NOTICEABLE SEEPAGE	NA	
STAFF GAGE AND RECORDER	NA	
DRAINS	NA	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CRACKING & SPALLING OF CONCRETE SURFACES IN STILLING BASIN	NA	
INTAKE STRUCTURE	The Intake into Dundee Canal is in serious disrepair. The riverward channel is closed off by a Mitre type timber gate in deteriorated condition. Canal water enters this gate through narrow paddle gates rotating on vertical axes. The land side channel has 3 timber lift gates and a timber bulkhead. This pass is apparently more watertight, but the gates are inoperable. The River Wall of the Canal Intake has been lowered to create a side weir for the control of the canal water surface during high Passaic River stages.	Check intake gates on both river and land side passes of canal for structural strength, rebuild as required. Repair eroded area at foot of river wall below side weir.
OUTLET STRUCTURE	A gate house downstream of the Canal Intake contains metal lift gates for draining the canal and are useful as a low level outlet. This installation is in an advanced state of dilapidation, partially vandalized and not operable. The gates leak approximately 250 gpm into the river.	Restore canal drain outlet gate house and gates to original use as a canal drain and low level outlet.
OUTLET CHANNEL	Dundee Canal along the right abutment and bank of the Passaic River is approx. 2-mile long and is used to supply raw water for industrial uses. The canal banks are overgrown with brush in many places. No actual leakage was observed, but the irregularly graded land side canal bank slope shows signs of deterioration in the reach between Dundee Dam and Outwater Street. South of Outwater Street, the canal veers away from the river. The canal enters a concrete conduit at Monroe Street and remains in culvert south of this point.	Dress canal bank slopes, eliminate erosion gullies. Remove excessive brush growth from canal banks and slopes.
EMERGENCY GATE	NA	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONCRETE WEIR	Broad crested weir, stepped downstream face of masonry construction. See comments under "Concrete/Masonry Dams".	
APPROACH CHANNEL	None	
DISCHARGE CHANNEL	No formal channel; entire river bed serves as downstream channel. No energy dissipation facility has been provided.	
BRIDGE AND PIERS	None	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONCRETE SILL	NA	
APPROACH CHANNEL	NA	
DISCHARGE CHANNEL	NA	
BRIDGE AND PIERS	NA	
GATES & OPERATION EQUIPMENT	NA	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
MONUMENTATION/ SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENTATIONS
SLOPES	Well defined, no bank protection observed.	
SEDIMENTATION	There should be considerable sedimentation since the dam is 120-years old; however, the presence of upstream impoundments should lessen the sedimentation impact somewhat.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The channel of the Passaic River downstream of the dam is a well defined waterway with 10 to 12-foot high banks. There is a small island downstream of the dam which does not affect the conveyance capacity of the stream reach.	
SLOPES	Fairly steep, estimated at 1 vertical on 2 horizontal.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	There are very many business and industrial establishments situated along the banks of the Passaic River and Dundee Canal downstream of the dam axis.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	No original dam drawings or sketches available. Some drawings dating from a 1937 WPA survey project on the Passaic River show Dundee Lake Dam, but not in sufficient detail.
REGIONAL VICINITY MAP	Available
CONSTRUCTION HISTORY	Not available.
TYPICAL SECTIONS OF DAM	Available but not detailed enough to base a definitive stability analysis.
HYDROLOGIC/HYDRAULIC DATA	Gage records for Passaic River are available.
OUTLETS - PLAN	None available
- DETAILS	
- CONSTRAINTS	
- DISCHARGE RATINGS	
RAINFALL / RESERVOIR RECORDS	General precipitation records are available for New Jersey. No specific rain gage data is kept at the dam site.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

ITEM	REMARKS
DESIGN REPORTS	None available.
GEOLOGY REPORTS	None available.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None available.
POST-CONSTRUCTION SURVEYS OF DAM	1939 WPA stream survey exists. In 1870, an investigation was conducted to determine the extent of undercutting of the masonry weir at toe in the vicinity adjacent to the canal intake wall. In 1974, another underwater inspection was computed and a report filed.
BORROW SOURCES	Not applicable; source of stone for weir construction unknown.
SPILLWAY PLAN - SECTIONS - DETAILS	Available, but not detailed enough to base definitive stability analysis.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

ITEM	REMARKS
OPERATING EQUIPMENT PLANS AND DETAILS	None available.
MONITORING SYSTEMS	None.
MODIFICATIONS	Plans for general rehabilitation prepared by the Hackensack Water Company, dated 1978.
HIGH POOL RECORDS	None available.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Report on main overflow weir foudation undercutting dated 1870; another dated 1974 - See Modifications.
PRIOR ACCIDENTS OF FAILURE OF DAM - DESCRIPTION - REPORTS	See above.
MAINTENANCE OPERATION RECORDS	See above.

APPENDIX B

PHOTOGRAPHS

ALL PHOTOGRAPHS TAKEN DURING MAY 1978

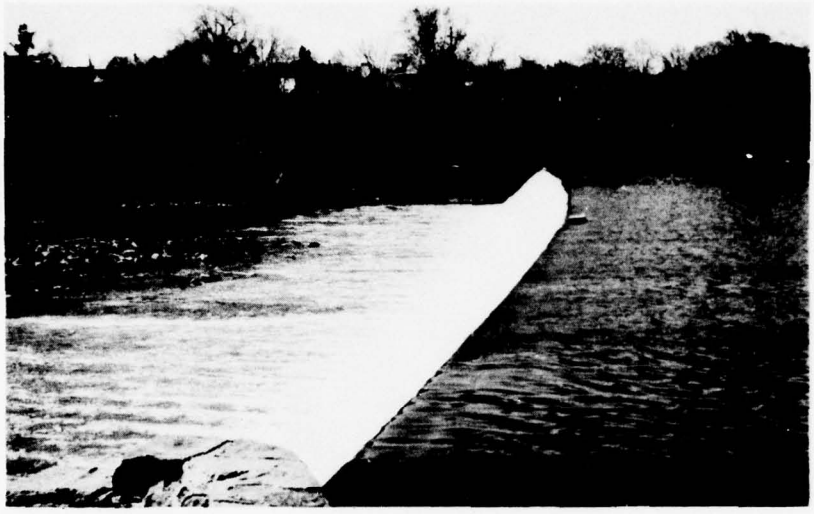


Photo 1 - General view from left bank toward right abutment and canal intake on right bank

Photo 2 - View from downstream left bank looking toward right abutment

Photo 3 - View from downstream left bank at left abutment

Photo 4 - Close-up view of left abutment; seepage is coming out at a point half way between the figure and the spillway training wall

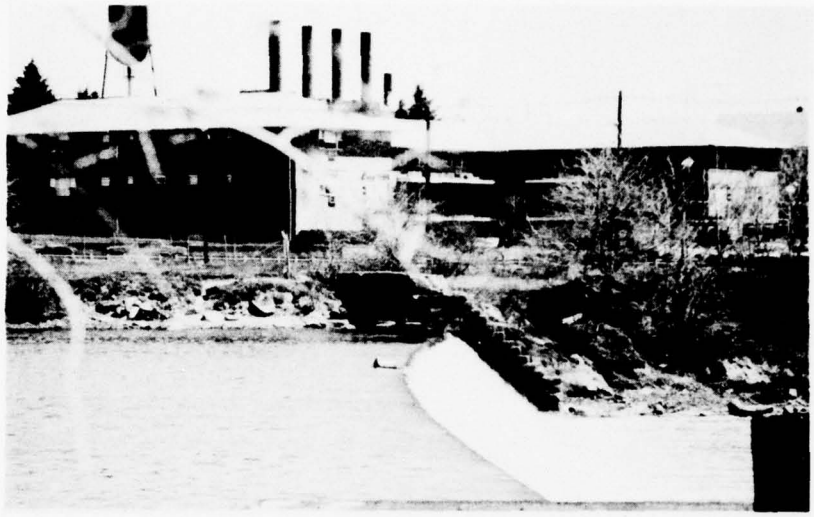


Photo 5 - View of left abutment and left spillway training wall from right abutment

Photo 6 - Close-up view of left abutment area downstream of dam showing stream bank erosion caused by local street drainage overflow

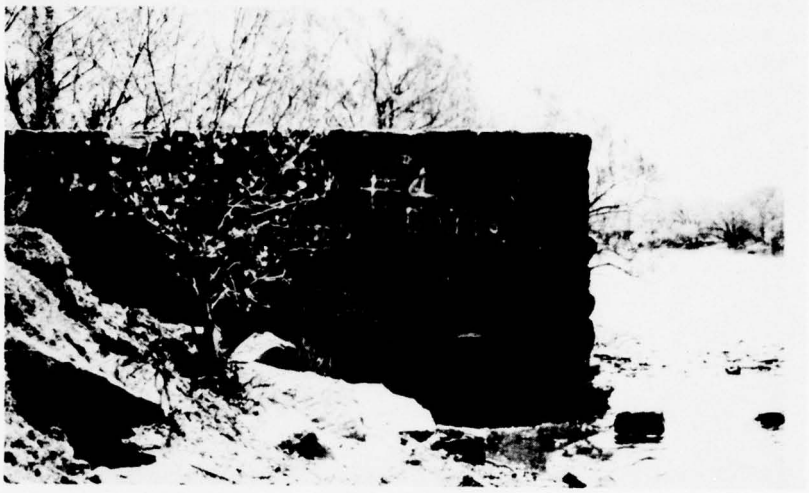


Photo 7 - View of left abutment from upstream side of dam

Photo 8 - View of right bank and Dundee Canal intake. The vertical lift gates in the landward pass are inoperative. The Mitre gate in the riverward pass has vertical axis paddle gates that permit water to enter the canal for industrial use. This installation is in an advanced state of dilapidation

Photo 9 - River wall of Dundee Canal intake; the wall has been lowered to act as a water level control weir for the Dundee canal at high flow rates of the Passaic River; wall is leaking at places through masonry joints

Photo 10 - View of Dundee Canal intake center wall (with railing) and cut down river wall acting as a sideweir beyond it

Photo 11 - General view of Dundee Canal intake from right canal bank looking upstream

Photo 12 - View of right abutment downstream of dam axis from left bank showing canal bank and gate house used originally for emptying of canal and as low level outlet

Photo 13 - View of gate house looking across Dundee Canal toward left abutment

Photo 14 - Close-up of gate house outlet on river side of canal embankment showing leakage through inoperative gates; entire gate house is in advanced state of ruin

Photo 15 - View of Dundee Canal looking upstream of crossing at Ackerman Avenue, Clifton, NJ

Photo 16 - View of Dundee Canal looking downstream of crossing at Ackerman Avenue, Clifton, NJ

APPENDIX C

SUMMARY OF ENGINEERING DATA

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

Name of Dam: DUNDEE LAKE DAM

Drainage Area Characteristics: 809.9 square miles on the Passaic River, Passaic River Basin

Elevation Top Normal Pool (Storage Capacity): 25.40*

Elevation Top Flood Control Pool (Storage Capacity): NA

Elevation Maximum Design Pool: 29.40

Elevation Top Dam: 34.8 (top of right wingwall)

SPILLWAY CREST:

a. Elevation 25.40 (at center point)
b. Type Overflow weir
c. Width 4.0
d. Length 450 feet
e. Location Spillover Entire length between the abutments
f. No. and Type of Gates None

OUTLET WORK:

a. Type Two channels combining into Dundee Canal
b. Location Left side of the dam
c. Entrance Inverts 11.10 MSL
d. Exit Inverts NA
e. Emergency Draindown Facilities In ruin; not operable

HYDROMETEOROLOGICAL GAGES:

a. Type None at site of dam
b. Location NA
c. Records NA

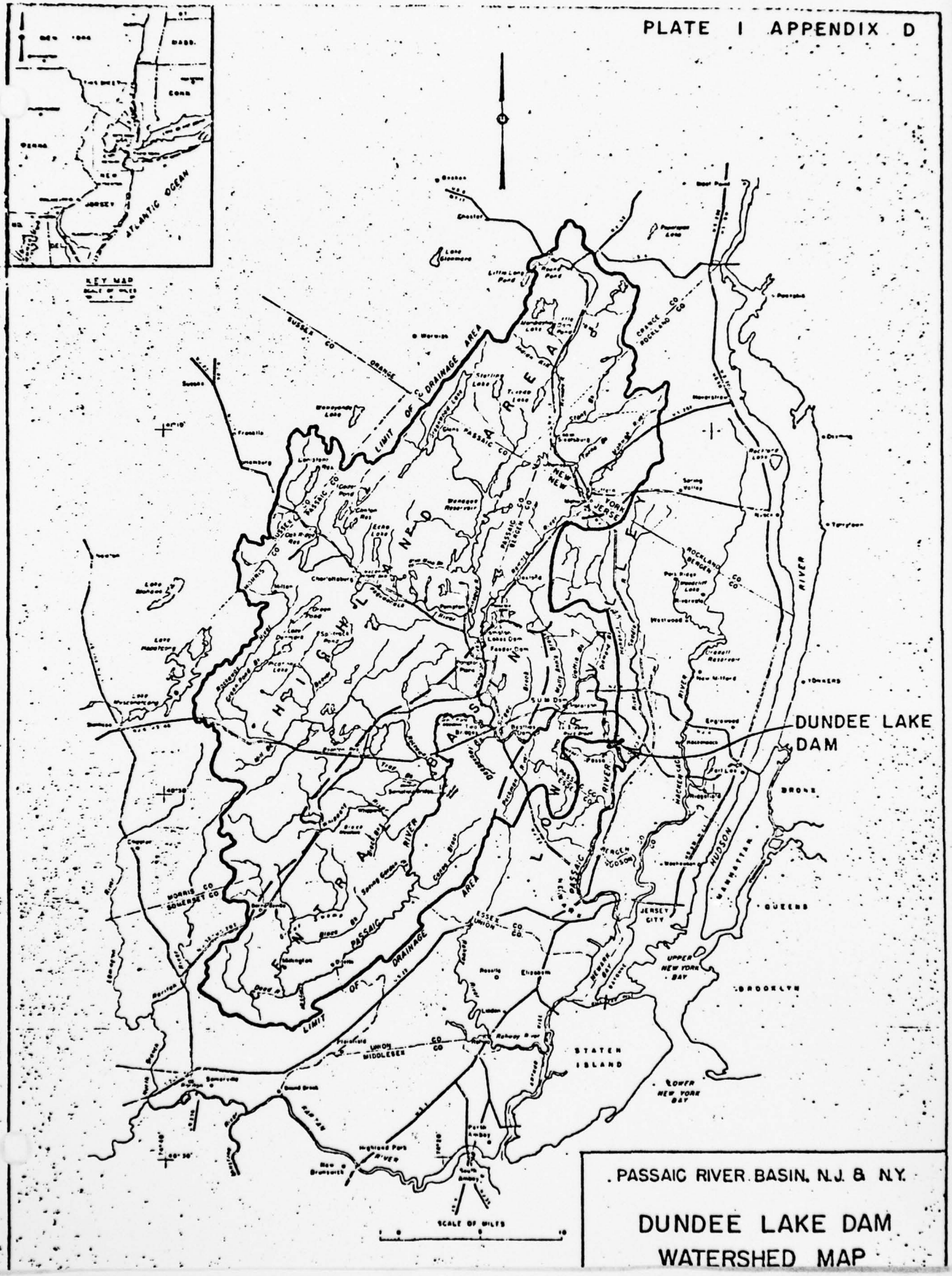
MAXIMUM NON-DAMAGING DISCHARGE 35,800 cfs on October 8, 1903; Lake at elevation 33.02

* top of spillway crest - add depth of run-of-river discharge over weir

APPENDIX D

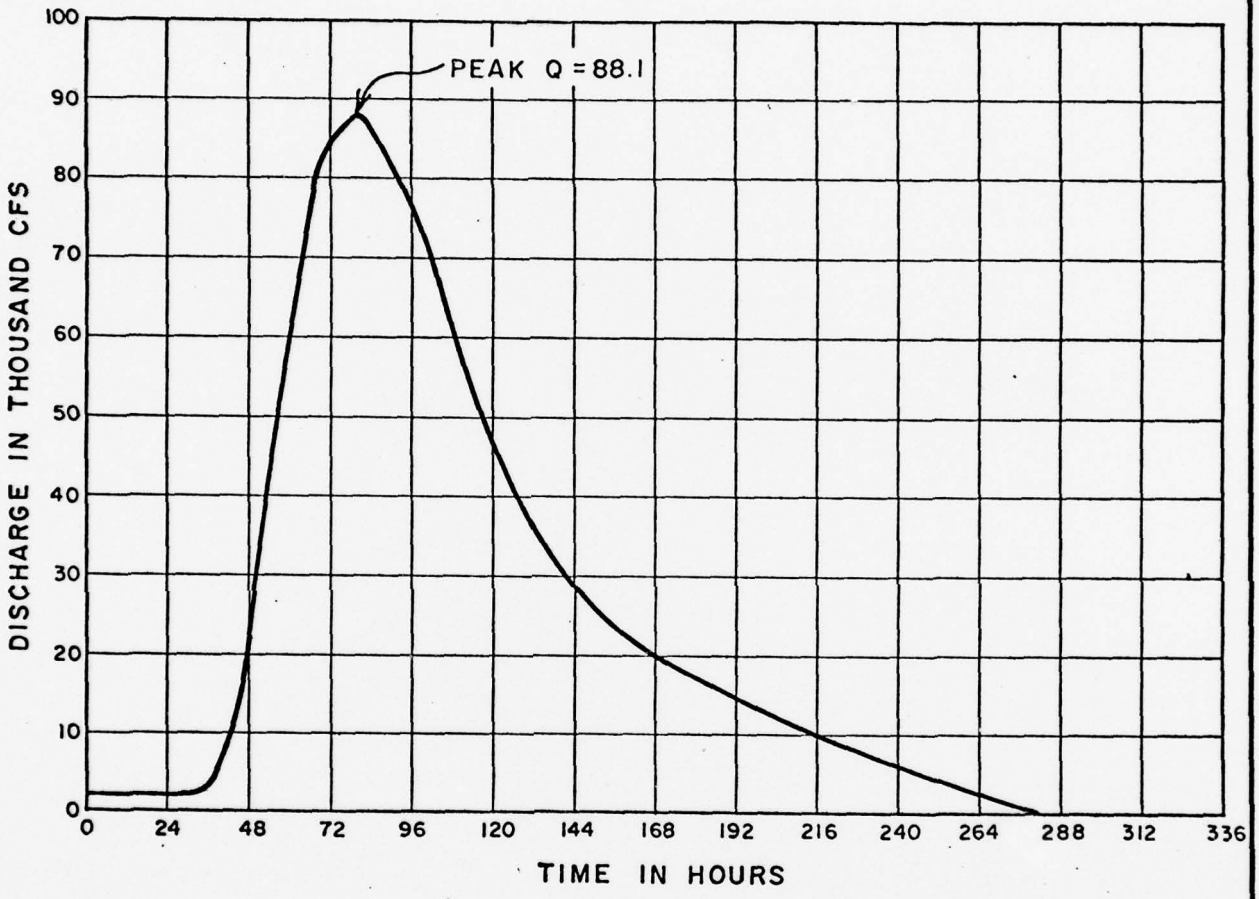
HYDROLOGIC COMPUTATIONS

PLATE I APPENDIX D



PASSAIC RIVER BASIN, N.J. & N.Y.

DUNDEE LAKE DAM
WATERSHED MAP



DUNDEE DAM
PROBABLE MAXIMUM FLOOD HYDROGRAPH

DAM SAFTEY INSPECTION - NEW JERSEY
DUNDEE LAKE DAM
56% OF PMF FLOOD ROUTING

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	3	0	0	0	0	0	0	4	0

JOPER NWT
5 0

FLOOD ROUTING PRIOR TO OVERTOPPING

SUB-AREA RUNOFF COMPUTATION

INPUT KNOWN PMF HYDROGRAPH FOR DUNDEE LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
4	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
-1	0	809.90	0.00	809.90	0.00	560.000	0	0	0

HYDROGRAPH ROUTING

ROUTE ONE HALF OF PMF FLOOD THROUGH DUNDEE LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
4	1	0	0	0	0	1

ROUTING DATA

GLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	0

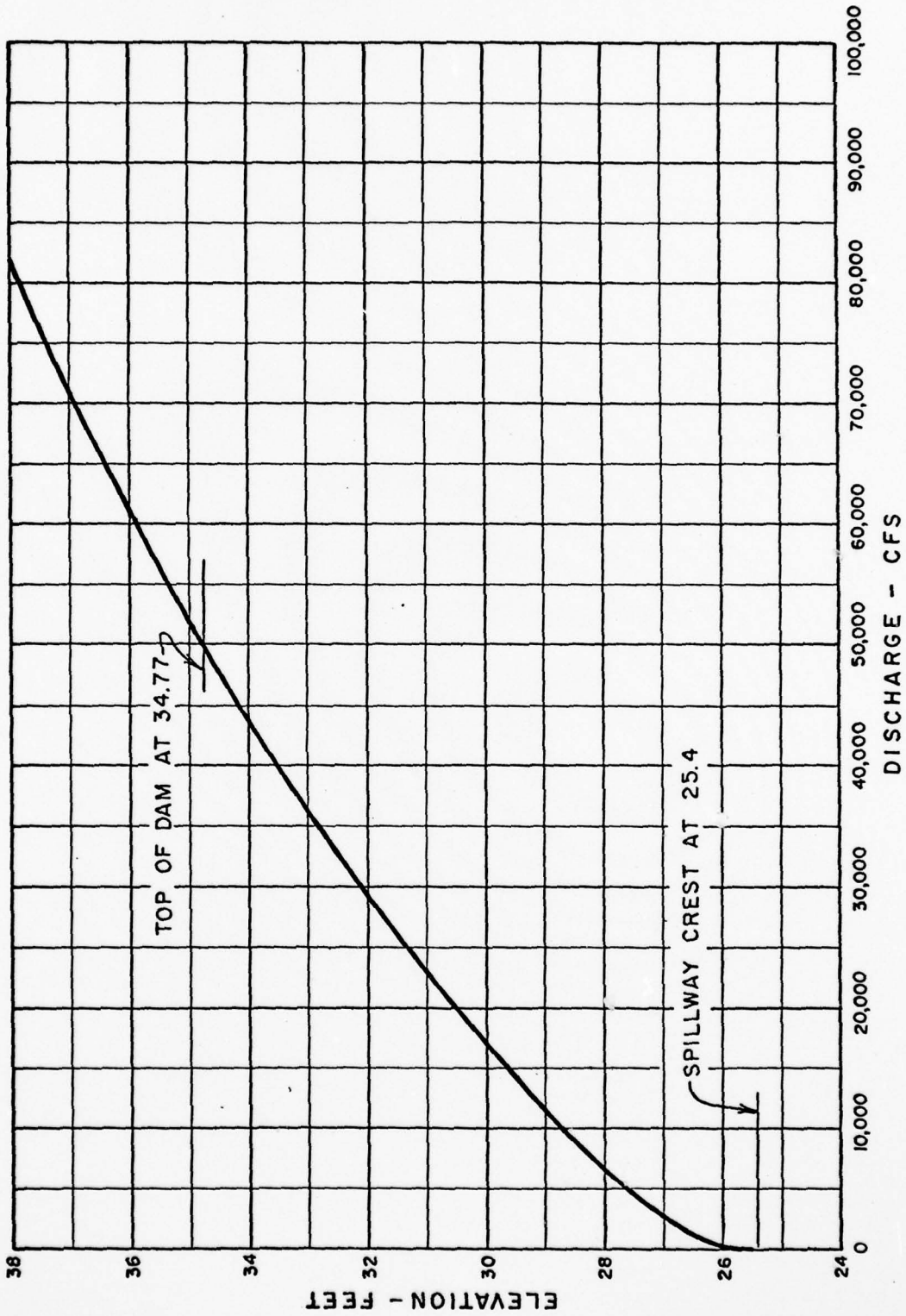
NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.000	0.000	0.000	-1.

STORAGE=	0.	350.	710.	1075.	1770.	2500.	3250.	4240.	5350.
OUTFLOW=	0.	2600.	8800.	16600.	25800.	36000.	47900.	61400.	76300.

RUNOFF SUMMARY, AVERAGE FLOW

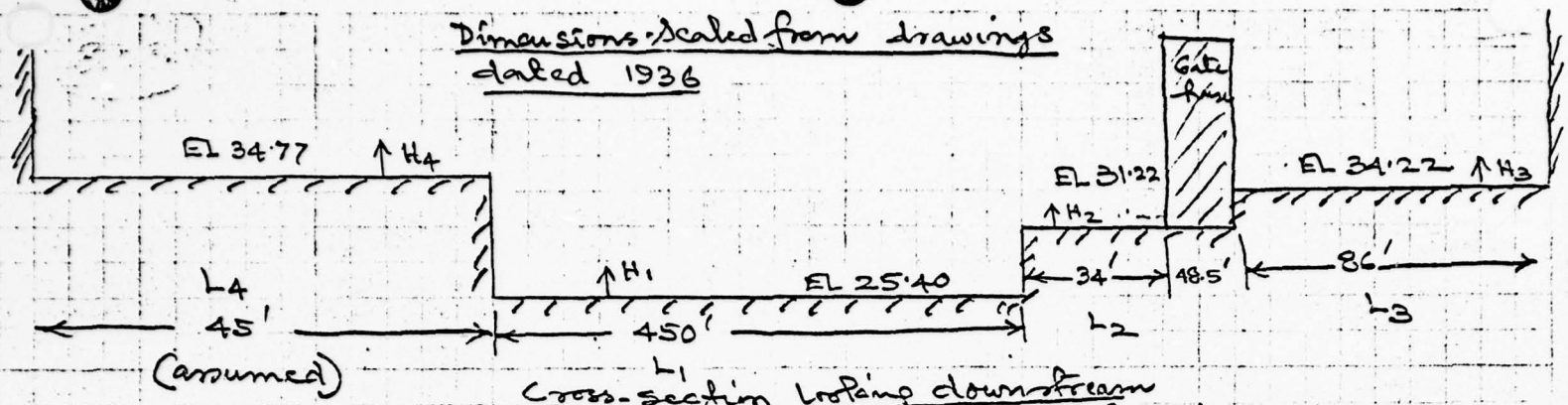
		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	4	49336.	49027.	47606.	38670.	809.90
ROUTED TO	4	49136.	49068.	47608.	38682.	809.90

PLATE 3 - APPENDIX D



DUNDEE LAKE DAM
SPILLWAY AND OVERTOP RATING CURVE

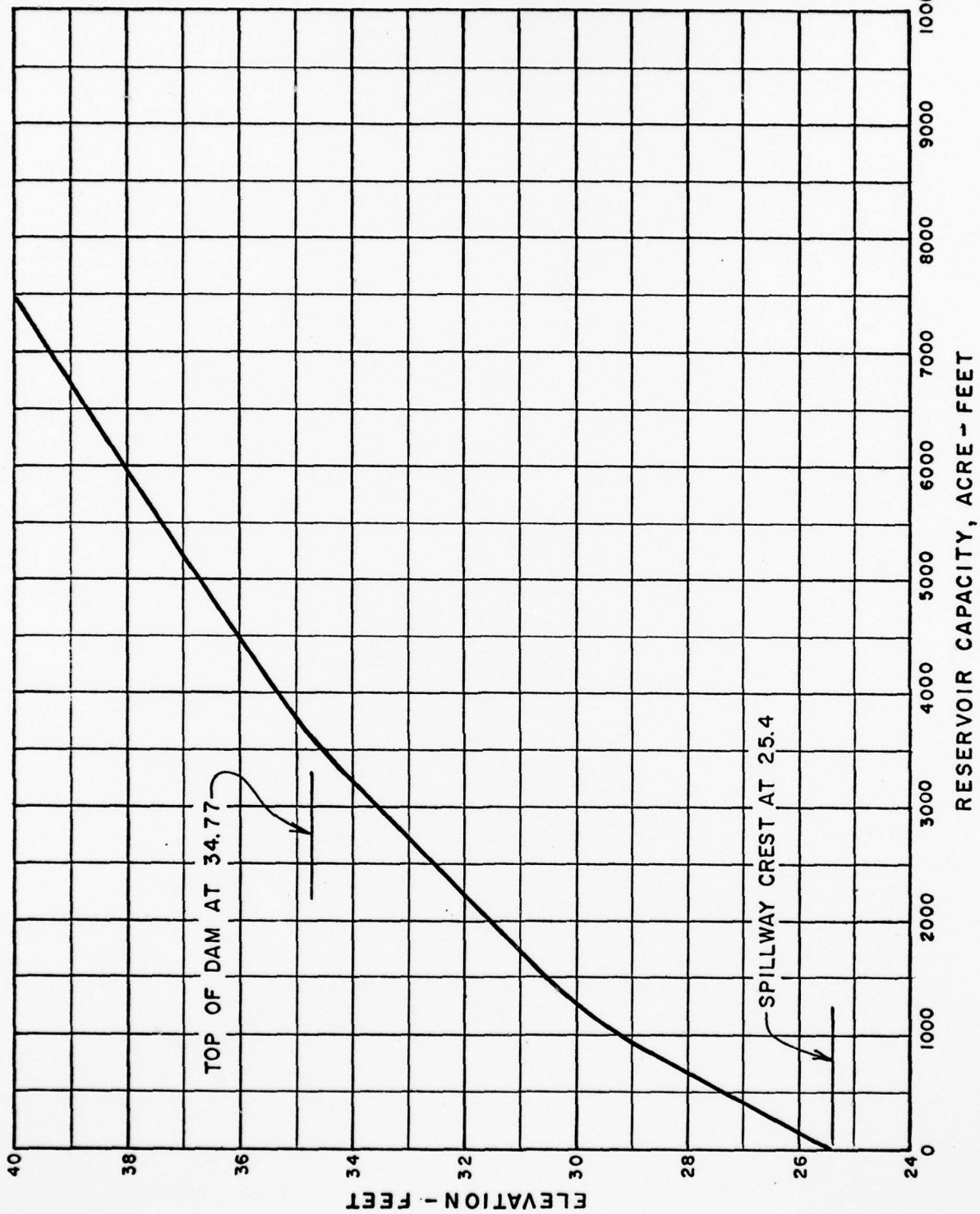
Dimensions scaled from drawings dated 1936



Cross-section looking downstream

Assume channels are closed and Gate House an obstruction block

EL.	H_1	H_2	H_3	H_4	L_1	L_2	L_3	L_4	C_1	C_2	C_3	C_4	$Q = C_1L_1H_1^{1.5} + C_2L_2H_2^{1.5} + C_3L_3H_3^{1.5} + C_4L_4H_4^{1.5}$	
25.40	0													
26.40	1				450				3.2				1440+0+0+0	= 1,440
27.46	2				450				3.4				4328+0+0+0	= 4,328
29.40	4				450				3.7				13320+0+0+0	= 13,320
31.22	5.82	0			450				3.8				24,009+0+0+0	= 24,009
32.22	6.82	1			450	34			3.8	3.2			30,456+109+0+0	= 30,565
34.22	8.82	3	0		450	34			3.8	3.6			44,792+636+0+0	= 45,428
34.77	9.37	3.55	0.55	0.	450	34	86		3.8	3.6	3.2		49,046+819+112+0	= 49,977
36.40	11.0	5.18	2.18	1.63	450	34	86	45	3.8	3.8	3.4	3.3	62,386+1523+941+309	= 65,159
38	12.6	6.78	3.78	3.23	450	34	86	45	3.8	3.8	3.7	3.6	76,481+2281+2339+940	= 82,041



DUNDEE LAKE DAM
NET RESERVOIR CAPACITY CURVE
ABOVE SPILLWAY CREST

NEW JERSEY DAM SAFETY INSPECTION — SHEET NO. 1 OF 1
DUNDEE LAKE DAM — JOB NO. 1209-001
RESERVOIR AREA-CAPACITY DATA — BY MAS DATE July 7, 7

DUNDEE LAKE DAM

RESERVOIR AREA CAPACITY DATA

SUMMARY

Elevation (Feet)	Reservoir Surface Area (Acres)	Reservoir Volume (AC-FT)	Net Vol. of Reservoir Above Spillway Crest (AC-FT)	Remarks
25.40	(224)	3584	0	Assuming area of reservoir 224 acres to be at El. 25.4 & normal vol. of 3584 A.F. to be at Spillway crest El. 25.4.
29.42	(833)	4704	1120	Assuming maximum Vol. of 4704 at El 29.42 (Floor level of gate house). Worked backward to obtain the area.
34.77	(600)	7200	3616	The area of 600 acres is obtained by interpolating area between the 20' & 40' contours.
40.00	871	11047	7463	

Note: Taken from "Passaic River Report", Dept. of the Army, New York District Corps of Engineers, 6/72

TABLE A12

COMPARATIVE FLOOD DATA - MAXIMUM FLOODS OF RECORD, PASSAIC RIVER BASIN, N. J.

COMPARISON OF REPRODUCED AND OBSERVED DATA, FLOODS OF OCTOBER 1903

Stream and Locality	Gross Drainage Area (sq.mi.)	Reproduced Flood Values		Observed or Estimated by Other Agencies		
		Peak Discharge (c.f.s.)	Day and Hour of Peak	Peak Discharge (c.f.s.)	Day and Hour of Peak	Authority
Passaic R. at Millington	55.4	2,000	10th, 12 am	-	-	-
Passaic R. at Chatham	100.0	5,150	9th, 8 pm	2,400 a	10th, 12 am	D
Passaic R. at Chatham	-	-	-	-	9th, 12 pm	A
Passaic R. at Chatham	-	-	-	-	11th, 7 am	B
Rockaway R. at Boonton (d)	119.3	9,500	10th, 1 am	7,560 b	10th, 4 am	D, E
Rockaway R. at Boonton (d)	-	-	-	5,764 a	10th, 4 am	A, B
Whippany R. at Morristown	29.4	3,200	9th, 11 pm	-	-	-
Whippany R. at Whippany	38.0	-	-	2,500	9th, 12 pm a	D
Whippany R. at Whippany	-	-	-	-	9th, 5 pm	A
Ramapo R. at Mahwah	118.0	-	-	12,400	9th -	E, F
Ramapo R. at Pompton Lakes	160.0	15,800	9th, 9 pm	9,000 a	9th, 1 pm	A, B
Wanaque R. at Wanaque	90.4	11,100	9th, 10 am	-	-	-
Wanaque at Mouth	108.1	14,100	9th, 11 am	8,440 a	9th, 12 am	A, D, F
Pequannock R. at Macopin Dam	43.7	5,600	10th, 4 am	5,800 a	10th, 4 am	D
Pequannock R. at Macopin Dam.	-	-	-	6,100 c	10th -	E, F
Pequannock R. excluding Wanaque	84.5	6,830	9th, 7 pm	-	-	-
Pompton R. at Feeder Dam	353.8	36,000	9th, 1 pm	28,300 a	10th, 6 am a	D, F
Pompton R. at Mountain View	377.3	34,000	9th, 12 pm	23,400 a	9th, 4:30pm to 10th, 12 am	A, F
Passaic R. at Little Falls	762.2	32,700	11th, 3 am	31,700	10th, 4 pm	A, C, F
Passaic R. at Little Falls	-	-	-	32,700	10th, 6 pm	G
Passaic R. at Paterson (S.U.M.)	785.0	33,700	-	28,000 b	10th	F
Passaic R. at Dundee	809.9	35,800	-	35,800	10th, 9 pm	A, E, F

A = New Jersey State Geologist, Report of 1903.
B = Northern New Jersey Flood Commission, Report of 1904.
C = U. S. Geological Survey, Water Supply Paper No. 92 (1904).
D = New Jersey State Water Policy Commission, Report of 1931.
E = U. S. Geological Survey, Water Supply Paper No. 799 (1936)
F = U. S. Geological Survey, Water Supply Paper No. 847
G = New Jersey Dept. of Conservation and Development (C C Vermeule) 1928

a. Estimated value
b. Maximum daily discharge
c. Maximum daily discharge, 5,360 c.f.s.
d. Below reservoir.

COMPARATIVE DISCHARGES OF MARCH 1902 AND OCTOBER 1903 FLOODS

Source of Data	Little Falls - Beatties Dam D.A. = 762.2 sq. mi.					Clifton - Dundee Dam D.A. = 809.9 sq. mi.				
	Discharge		Volume			Discharge		Volume		
	Peak (c.f.s.)	Peak Time	Inches	Time Limits From	Time Limits To	Peak (c.f.s.)	Peak Time	Inches	Time Limits From	Time Limits To
October 10, 1903										
U.S.G.S. 1904	31,675	2 pm - 8 pm a 6 pm a	6.61	10/8 6 pm	10/17 6 am	35,800	9 pm	7.83 b	10/8 6 am	10/17 9 am
U.S.G.S. 1937	31,700	-	-	-	-	35,800	-	-	-	-
Vermeule 1903	-	2 pm	-	-	-	31,410	8 pm	7.12 c	-	-
Vermeule 1928	32,628	6 pm	6.22c	-	-	31,410	-	6.24 d	-	-
N.J.F.C. 1904 f	-	-	-	-	-	37,300	9 pm	7.10	10/9 4 am	10/17 10am
Adopted	31,700	2 pm	6.22	10/8 6 pm	10/17 6 am	35,800	9 pm	6.50	10/8 6 am	10/17 9 am
March 2, 1902										
U.S.G.S. 1902	23,600	12 M	6.35	2/25 12M	3/8 6 pm	25,000	6 pm	6.93 e	2/25 12 M	3/8 6 pm
U.S.G.S. 1937	21,200	-	-	-	-	25,000	-	-	-	-
Vermeule 1902	21,207	9 am	-	-	-	22,677	7 pm	5.35 e	-	-
Vermeule 1928	21,207	12 M	-	-	-	22,677	-	-	-	-
N.J.F.C. 1904 f	-	-	-	-	-	26,000	6 pm	6.25	2/25 12 M	3/8 6 pm
Adopted	21,200	12 M	5.94	2/25 12M	3/8 6 pm	24,000	6 pm	5.82	2/25 12 M	3/8 6 pm

a. U.S.G.S. - United States Geological Survey - W.S. & I Paper 92 (1904 Report) (Pages 9, 16 and 17)
b. Reported as 7.83 Inches of Runoff on Page 19 Reference (a)
c. Reported as 7.10 Inches of Runoff on Page 19 Reference (a)
d. New Jersey Department of Conservation & Development (1928 Report) by C.C. Vermeule (Page 15)
e. Geological Survey of New Jersey (1903 Report) by C.C. Vermeule (Page 24)
f. N.J.F.C. - Northern New Jersey Flood Commission

AD-A058 152 HARRIS ECI ASSOCIATES WOODBRIDGE NJ F/G 13/2
NATIONAL DAM SAFETY PROGRAM. DUNDEE LAKE DAM (NJ00243). PASSAIC--ETC(U)
JUN 78 R GERSHOWITZ DACW61-78-C-0100
UNCLASSIFIED NL

2 OF 2
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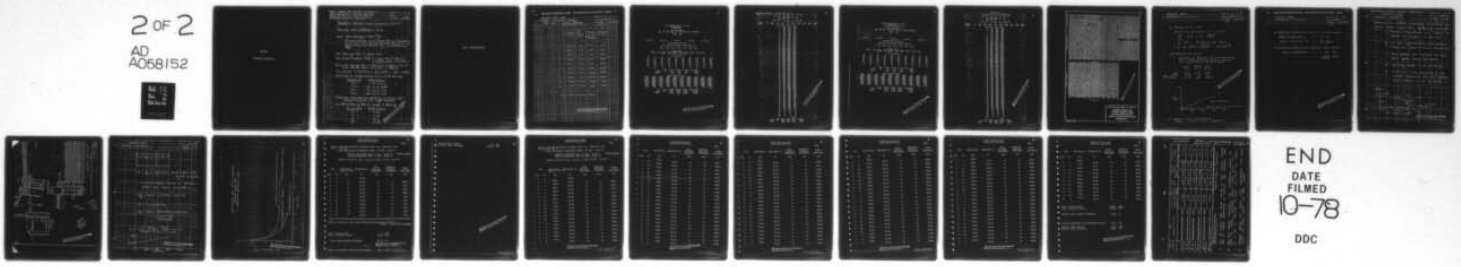

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APPENDIX

HYDROLOGIC COMPUTATION

NEW JERSEY DAM SAFETY INSPECTION. SHEET NO. ____ OF 9
PMF DERIVATION - DUNDEE LAKE DAM JOB NO. ____
Probable Maximum Precipitation. BY YIN DATE MAY.

PROBABLE MAXIMUM FLOOD CALCULATION (PMF)

DRAINAGE AREA = 809.9 square Miles.

From Hydrometeorological Report #33

"Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Duration of 6, 12, 24 and 48 Hours" 1956.

For Drainage Area 10 square Miles

the 6 Hour duration PMP is 24.5 inches for Zone "6" at DUNDEE LAKE watershed.

Since the drainage area is larger than 10 square miles, an area reduction factor of (.60) is applied.

The reduced 6 Hour PMP is .60 × 24.5 = 14.7 inches.

PMP values for rainfall durations of 6, 12, 24, 48 hours are:

Duration (Hrs)	PMP (inches)
6 hr	1 × 14.7 = 14.7
12 hr.	1.08 × 14.7 = 15.88
24 hr.	1.21 × 14.7 = 17.79
48 hr.	1.34 × 14.7 = 19.70

PMP values shown above are reduced by 10% to account for misalignment of basin and rainfall isohyetals.

the PMP for deriving PMF are therefore as following:

Duration (Hrs)	PMP (inches)
6	13.23
12	14.29
24	16.01
48	17.73

HEC 1 - COMPUTATIONS

EC1-4 ENGINEERING CONSULTANTS, INC.

DUNDEE LAKE DAM — SHEET NO. 1 OF

VOLUME - DISCHARGE CURVES — JOB NO. 1209-001-1

FOR HEC-1 INPUT - BACKUP — BY KLB DATE 7-22-78

Unit

		ELEVATION (FT)	HEAD ABOVE SPILLWAY (FT)	Y2 VOLUME (AC-FT) (RELATIVE TO SPILLWAY)	Y3 DISCHARGE (CFS)
1		25.4	0.	0.	0.
2		27.0	1.60	350.	2600.
3		28.5	3.10	710.	8800.
4		30.0	4.60	1075.	16600.
5		31.5	6.10	1770.	25800.
6		33.0	7.60	2500.	36000.
7		34.5	9.10	3250	47900.
8		36.0	10.60	4240.	61400.
9		37.5	12.10	5350.	76300.
10		39.0	13.60	6500.	94500.

DATA TAKEN FROM GRAPHS

DAM SAFTEY INSPECTION - NEW JERSEY
DUNDEE LAKE DAM
PMF ROUTING

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	3	0	0	0	0	0	0	0	0

JOPER	NWT
3	0

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INPUT KNOWN PMF HYDROGRAPH FOR DUNDEE LAKE DAM

ISTAD	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
4	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
-1	0	809.90	0.00	809.90	0.00	1000.000	0	0	0

INPUT HYDROGRAPH

2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
2.	3.	5.	8.	13.	21.	31.	40.	51.	60.
68.	74.	81.	83.	85.	87.	88.	87.	85.	83.
80.	77.	73.	69.	65.	62.	58.	54.	50.	47.
44.	41.	38.	36.	33.	32.	31.	28.	27.	26.
24.	23.	22.	21.	21.	20.	19.	18.	17.	16.
15.	15.	14.	14.	13.	12.	12.	11.	11.	10.
10.	9.	9.	8.	8.	7.	7.	6.	6.	5.
5.	5.	4.	4.	3.	3.	2.	2.	2.	1.
1.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	88.	87.	85.	69.	2511.
INCHES		0.00	0.00	0.00	0.01
AC-FT		43.	168.	411.	622.

RUNOFF MULTIPLIED BY*****

2000.	2000.	2000.	2000.	2000.	2000.	2000.	2000.	2000.	2000.
2400.	3000.	5300.	8000.	13000.	21000.	31500.	40500.	51200.	60000.
68000.	74500.	81000.	83200.	85800.	87100.	88100.	87000.	85000.	83000.
80200.	77000.	73500.	69500.	65800.	62000.	58000.	54500.	50300.	47500.
44000.	41200.	38500.	36000.	33900.	32000.	31400.	28900.	27400.	26000.
24900.	23800.	22900.	21900.	21100.	20200.	19500.	18800.	17200.	16600.
16000.	15300.	14700.	14100.	13600.	12900.	12200.	11600.	11100.	10600.
10100.	9600.	9100.	8600.	8099.	7700.	7300.	6700.	6200.	5800.
5400.	5000.	4600.	4200.	3700.	3200.	2800.	2400.	2000.	1600.
1100.	600.	200.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	88100.	87549.	85012.	69054.	2511079.
INCHES		1.00	3.90	9.51	14.42
AC-FT		43435.	168706.	411112.	622902.

Hydrograph Routing

ROUTE THE FLOOD THRU DUNDEE DAM

ITRAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
0	1	0	0	2	0	1

ROUTING DATA

RLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.000	0.000	0.000	-1.

STORAGE=	0.	338.	710.	1075.	1770.	2500.	3200.	4240.	5330.	6589.
OUTFLOW=	0.	3600.	8800.	16600.	29800.	36000.	47900.	61400.	76500.	93332.

TIME	EOP STOR	AVG IN	EOP OUT
1	269.	2000.	2000.
2	269.	2000.	1999.
3	269.	2000.	2000.
4	269.	2000.	2000.
5	269.	2000.	2000.
6	269.	2000.	2000.
7	269.	2000.	2000.
8	269.	2000.	2000.
9	269.	2000.	2000.
10	269.	2000.	2000.
11	295.	2200.	2191.
12	356.	2700.	2712.
13	470.	4150.	4470.
14	626.	6650.	7366.
15	951.	10500.	11821.
16	1352.	17000.	18945.
17	1932.	26250.	29068.
18	2640.	36000.	35222.
19	3240.	45850.	48313.
20	3951.	54600.	57870.
21	4556.	64000.	65650.
22	5077.	71250.	72645.
23	5532.	77750.	79196.
24	5776.	82100.	83046.
25	5897.	84500.	84972.
26	6017.	86400.	86863.
27	6078.	87550.	87772.
28	6056.	87550.	87677.
29	5932.	86000.	85520.
30	5805.	84000.	83506.
31	5645.	81600.	80950.
32	5486.	78600.	77826.
33	5217.	75250.	74520.
34	4936.	71500.	70767.
35	4648.	67650.	66878.
36	4370.	63900.	63157.
37	4078.	60000.	59200.
38	3806.	56250.	55492.
39	3521.	52400.	51606.
40	3272.	48900.	48205.
41	3065.	45750.	44966.
42	2867.	42600.	41828.
43	2702.	39850.	39205.
44	2538.	37250.	36612.
45	2391.	34950.	34477.
46	2252.	32950.	32540.
47	2176.	31700.	31476.
48	2059.	30150.	29795.
49	1936.	28150.	27709.
50	1815.	26700.	26429.
51	1724.	25450.	25199.
52	1644.	24350.	24143.
53	1570.	23350.	23157.
54	1499.	22400.	22216.
55	1432.	21500.	21326.
56	1368.	20650.	20495.
57	1308.	19850.	19695.
58	1257.	19150.	19017.
59	1162.	18000.	17753.
60	1082.	16900.	16692.
61	1053.	16300.	16135.
62	1020.	15650.	15429.
63	991.	15000.	14805.
64	963.	14400.	14216.
65	938.	13850.	13684.
66	909.	13250.	13053.
67	878.	12550.	12322.
68	846.	11900.	11709.
69	821.	11350.	11157.
70	798.	10850.	10677.
71	775.	10350.	10193.
72	751.	9850.	9694.
73	728.	9350.	9196.
74	704.	8850.	8731.
75	676.	8350.	8222.
76	650.	7899.	7733.
77	628.	7500.	7397.
78	597.	7000.	6856.
79	565.	6498.	6332.
80	541.	6080.	5890.
81	518.	5608.	5494.
82	494.	5200.	5095.
83	471.	4800.	4693.
84	448.	4400.	4293.
85	421.	3949.	3825.
86	391.	3450.	3314.
87	366.	3000.	2886.
88	343.	2600.	2527.
89	297.	2200.	2213.
90	244.	1800.	1817.
91	184.	1350.	1369.
92	117.	844.	871.
93	86.	399.	419.
94	15.	100.	113.
95	0.	0.	0.
96	0.	0.	0.
97	0.	0.	0.
98	0.	0.	0.
99	0.	0.	0.
100	0.	0.	0.
SUM			9512173.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	97772.	97629.	95317.	69876.	9512173.
INCHES		1.08	5.99	9.52	84.42
AC-FT		93472.	340714.	911298.	6731?8.

DAM SAFTEY INSPECTION - NEW JERSEY
DUNDEE LAKE DAM
ONE HALF OF PMF FLOOD ROUTING

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	3	0	0	0	0	0	0	0	0

JOPER	NWT
3	0

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INPUT KNOWN PMF HYDROGRAPH FOR DUNDEE LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
4	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
-1	0	809.90	0.00	809.90	0.00	500.000	0	0	0

INPUT HYDROGRAPH

2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
2.	3.	5.	8.	13.	21.	31.	40.	51.	60.
69.	74.	81.	83.	85.	87.	88.	87.	85.	83.
80.	77.	73.	69.	65.	62.	58.	54.	50.	47.
44.	41.	38.	36.	33.	32.	31.	28.	27.	26.
24.	23.	22.	21.	21.	20.	19.	18.	17.	16.
16.	15.	14.	14.	13.	12.	12.	11.	11.	10.
10.	9.	9.	8.	8.	7.	7.	6.	6.	5.
5.	5.	4.	4.	3.	3.	2.	2.	2.	1.
1.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	88.	87.	85.	69.	2511.
INCHES		0.00	0.00	0.00	0.01
AC-FT		43.	168.	411.	622.

RUNOFF MULTIPLIED BY*****

1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.
1200.	1500.	2550.	4000.	6500.	10500.	15750.	20250.	25600.	30000.
34000.	37250.	40500.	41600.	42900.	43500.	44050.	43500.	42500.	41500.
40190.	38500.	36750.	34750.	32900.	31000.	29000.	27250.	25150.	23750.
22000.	20600.	19250.	18000.	16950.	16000.	15700.	14450.	13700.	13000.
12450.	11900.	11450.	10950.	10550.	10100.	9750.	9400.	8600.	8300.
8000.	7650.	7350.	7050.	6800.	6450.	6100.	5800.	5550.	5300.
5050.	4900.	4550.	4300.	4049.	3850.	3650.	3350.	3100.	2900.
2700.	2500.	2300.	2100.	1850.	1600.	1400.	1200.	1000.	800.
550.	300.	100.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	44050.	43774.	42506.	34527.	1255539.
INCHES		0.50	1.95	4.75	7.21
AC-FT		21717.	84353.	205556.	311451.

HYDROGRAPH ROUTING

ROUTE ONE-HALF OF PMF FLOOD THROUGH DUNDEE LAKE DAM

ISTAO	ICOMP	ICCON	ITAPE	JPLT	JPRT	INAME
0	1	0	0	2	0	1

ROUTING DATA

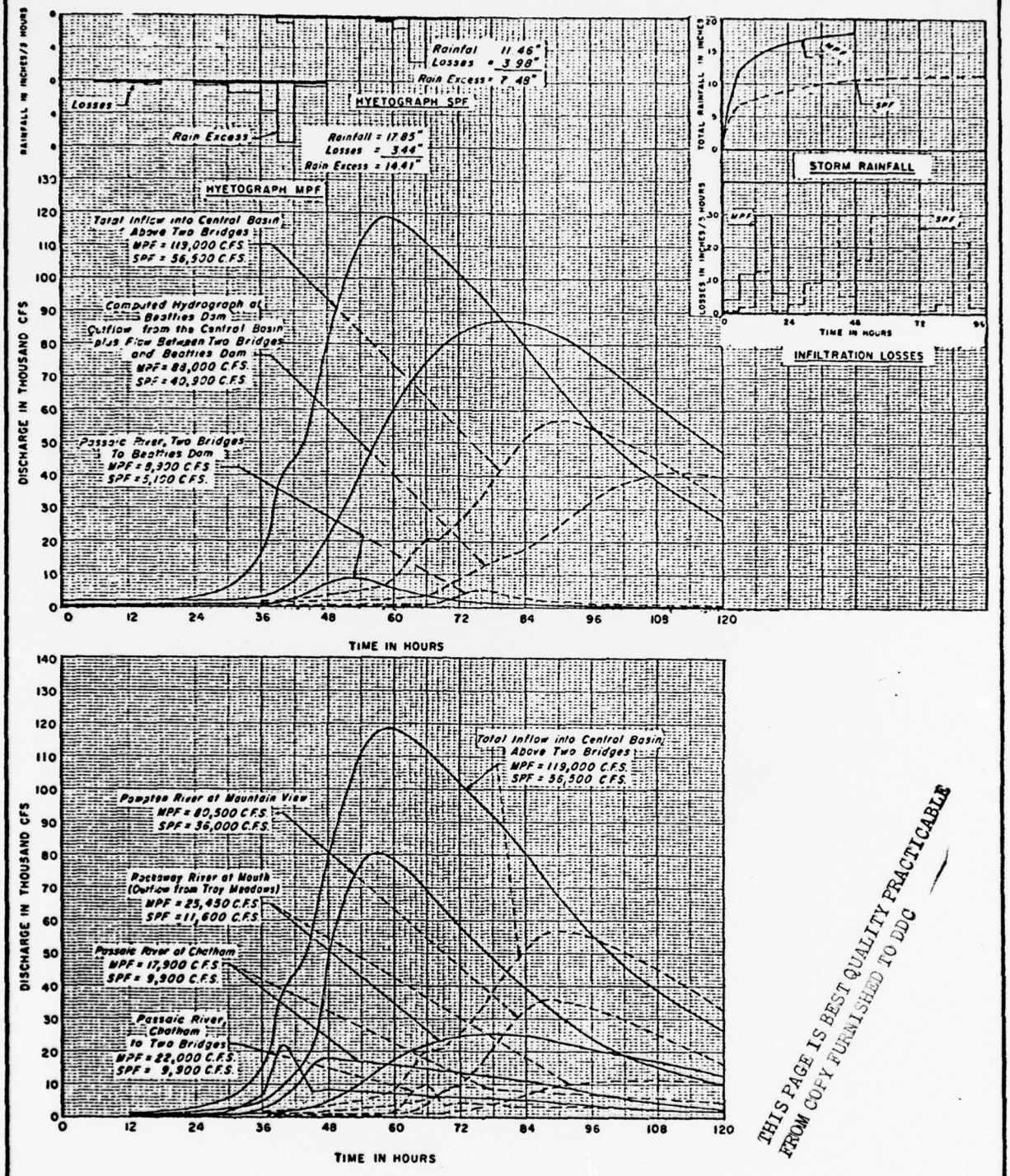
QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.000	0.000	0.000	-1.

STORAGE=	0.	853.	718.	3075.	1770.	8500.	3250.	4240.	5850.	4950.
OUTFLOW=	0.	2603.	8808.	16600.	25400.	36000.	47900.	61400.	76500.	93200.

TIME	EOP STOR	AVG IN	EOP OUT
1	134.	1000.	1000.
2	134.	1000.	999.
3	134.	1000.	1000.
4	134.	1000.	1000.
5	134.	1000.	1000.
6	134.	1000.	1000.
7	134.	1000.	1000.
8	134.	1000.	1000.
9	134.	1000.	1000.
10	134.	1000.	1000.
11	147.	1100.	1095.
12	190.	1350.	1339.
13	275.	2075.	2044.
14	405.	3325.	3454.
15	539.	5250.	5453.
16	742.	8500.	9437.
17	989.	13125.	14764.
18	1260.	18000.	19049.
19	1623.	22925.	23853.
20	1945.	27800.	28415.
21	2274.	32800.	32853.
22	2524.	35425.	36434.
23	2732.	38875.	39686.
24	2846.	41050.	41499.
25	2909.	42250.	42496.
26	2968.	43200.	43429.
27	2997.	43775.	43837.
28	2987.	43775.	43738.
29	2926.	43000.	42759.
30	2862.	42000.	41752.
31	2742.	40800.	40459.
32	2653.	39300.	38912.
33	2575.	37625.	37205.
34	2458.	35750.	35307.
35	2315.	33625.	33427.
36	2181.	31950.	31558.
37	2048.	30000.	29883.
38	1908.	28125.	27754.
39	1769.	26200.	25789.
40	1643.	24450.	24124.
41	1526.	22875.	22571.
42	1406.	21300.	20991.
43	1306.	19925.	19666.
44	1208.	18625.	18372.
45	1124.	17475.	17257.
46	1057.	16475.	16232.
47	1031.	15850.	15677.
48	990.	15075.	14802.
49	941.	14075.	13795.
50	914.	13350.	13171.
51	884.	12725.	12523.
52	860.	12175.	12017.
53	837.	11675.	11520.
54	815.	11200.	11055.
55	794.	10780.	10612.
56	775.	10325.	10175.
57	756.	9925.	9802.
58	741.	9575.	9472.
59	709.	9000.	8797.
60	682.	8450.	8327.
61	664.	8150.	8065.
62	647.	7825.	7730.
63	629.	7500.	7416.
64	612.	7200.	7121.
65	596.	6925.	6853.
66	578.	6525.	6542.
67	557.	6275.	6178.
68	539.	5950.	5867.
69	524.	5675.	5605.
70	510.	5425.	5359.
71	495.	5175.	5108.
72	481.	4925.	4858.
73	466.	4675.	4608.
74	452.	4425.	4358.
75	437.	4175.	4138.
76	425.	3969.	3892.
77	413.	3750.	3698.
78	398.	3500.	3428.
79	382.	3225.	3191.
80	370.	3000.	2985.
81	358.	2800.	2787.
82	344.	2600.	2582.
83	323.	2400.	2405.
84	297.	2200.	2208.
85	267.	1974.	1984.
86	233.	1725.	1735.
87	205.	1500.	1509.
88	176.	1300.	1308.
89	149.	1100.	1108.
90	122.	900.	908.
91	92.	675.	684.
92	58.	424.	435.
93	28.	199.	219.
94	7.	50.	56.
95	0.	0.	2.
96	0.	0.	0.
97	0.	0.	0.
98	0.	0.	0.
99	0.	0.	0.
100	0.	0.	0.
SUM			1256099.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	45887.	45817.	42588.	39535.	1256099.
INCHES		10.83	1.95	0.78	7.21
A-FT		21736.	84598.	235546.	3[illegible].



PASSAIC RIVER BASIN N.J. AND N.Y.

STANDARD PROJECT AND MAXIMUM PROBABLE FLOODS (EXISTING CONDITIONS WITH RAINFALL OVER ENTIRE BASIN ABOVE PATERSON N.J.)

FIGURE A64

DLINDEE DAM
RESERVOIR EVACUATION

SHEET NO. 1 OF
JOB NO. 1209.001-1
BY KLB DATE 7-17-78

a) DISCHARGE VS. HEAD.

(REFER TO MAS' NOTES OF 6-15-78)

$$\frac{V_c^2}{2g} = \frac{1}{3}h \; ; \; V_c \sqrt{\frac{3}{3}gh}$$

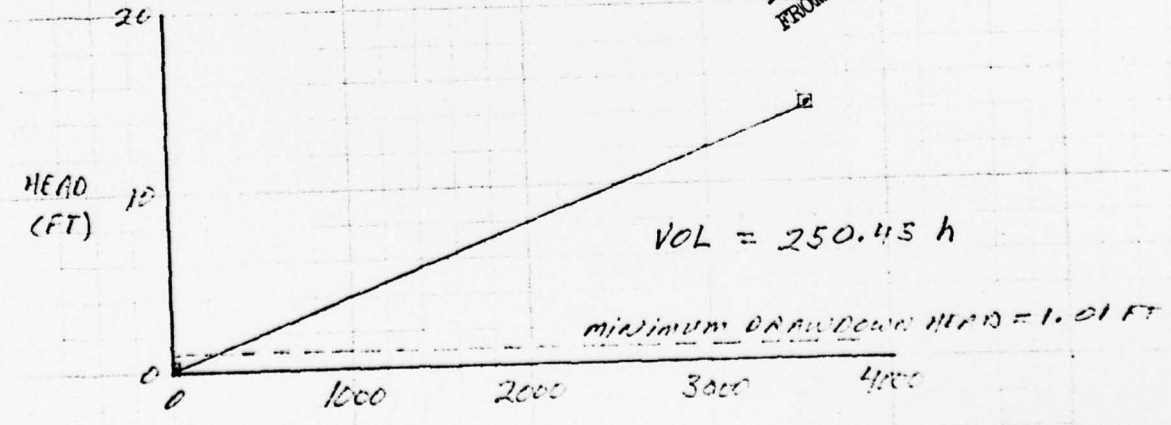
$$Q = A \cdot V_c, \quad A = 68.04\, Y_c = 68.\left(\frac{3}{3}\right)h$$

$$\therefore Q = 68.\left(\frac{3}{3}\right)h \times \sqrt{\frac{3}{3}gh} = 210.08\, h^{3/2}$$

b) STORAGE VS. HEAD

ASSUME A STRAIGHT LINE RELATIONSHIP FROM NORMAL WATER SURFACE VOLUME TO ZERO VOLUME AT ZERO HEAD

	ELEV (FT)	HEAD (FT)	VOL (AC-FT)
NWS	25.4	14.31	3584
MIN ELEV	11.09	0	0
MIN DRAWDOWN	12.10	1.01	252.96



c) DRAINAGE AREA = 809.9 SQ. MI.
INFLOW = 2 CFS X 809.9 = 1619.80 CFS

ECI-4 ENGINEERING CONSULTANTS, INC.

DUNDEE DAM
RESERVOIR EVACUATION

SHEET NO. 2 OF 4
JOB NO. 1209-001-1
BY KLB DATE 7-17-78

d) RESERVOIR EVACUATION TIME WITH CONSTANT INFLOW

(FROM COMPUTER PRINTOUT) = 44 HR

INFLOW ≈ OUTFLOW ⇒ = 1.83 DAYS

e) RESERVOIR EVACUATION TIME WITH ZERO INFLOW

(FROM COMPUTER PRINTOUT) = 20. HR

= 0.83 DAYS

NEW JERSEY DAM SAFETY INSPECTION — SHEET NO. 1 OF 18

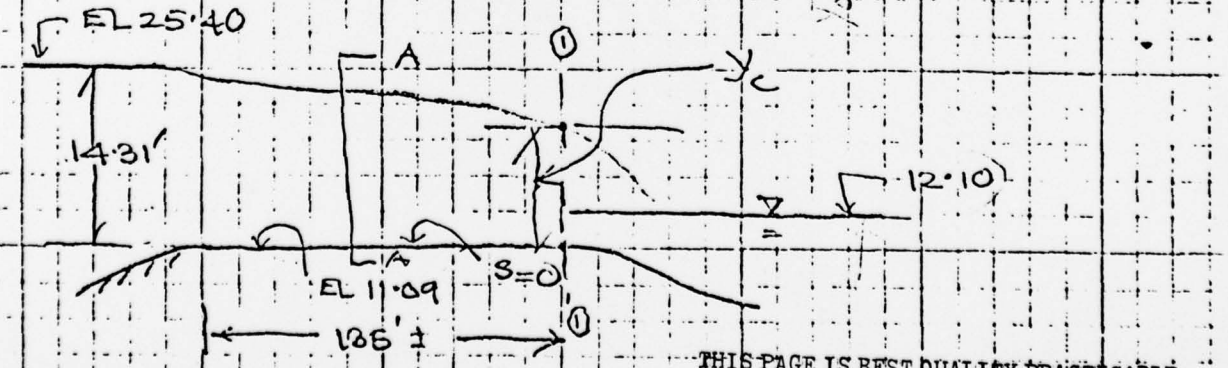
DUNDEE DAM — JOB NO. 1209-001

OUTLET CAPACITY — BY MA DATE 6-15

Determine outlet capacity of Dundee dam outlet works under the following assumptions

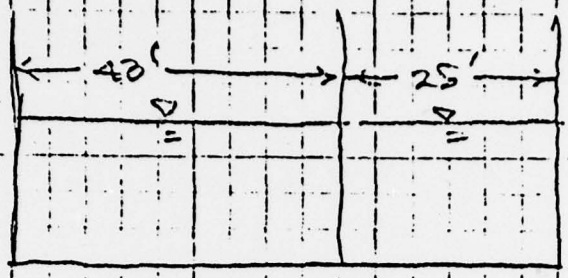
1. Assume downstream W.L. same as shown on page 2. ie El 12.10
2. Use the appropriate dimensions shown on page 2. Assume horizontal channel
3. The gates are raised to the floor gate house (El 29.42)
4. Spillway crest is at El 25.40
5. Determine the capacity of the outlet channel when the upstream water level is at El 25.40

SOLN:



JUNIPER DAM

OUTLET CAPACITY



$\therefore y_c = \frac{2}{3} H = \frac{2}{3}(14.31) = 9.54' > (12.10 - 11.09)$

Control at Section 1-1.

∴ Critical depth occurs at Section 1 under the above assumptions.

$\therefore \frac{V_c^2}{2g} = \frac{1}{3} H = \frac{1}{3}(14.31) = 4.77$ ft

$V_c = 17.53$ ft/sec.

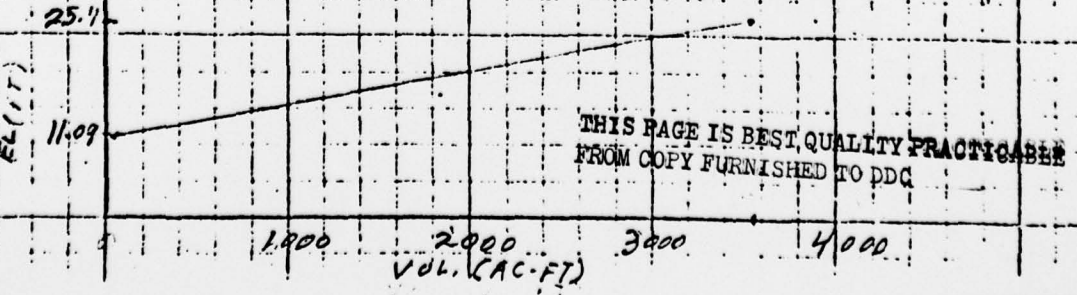
$\therefore Q = AV_c = (43+25)(9.54)(17.53)$

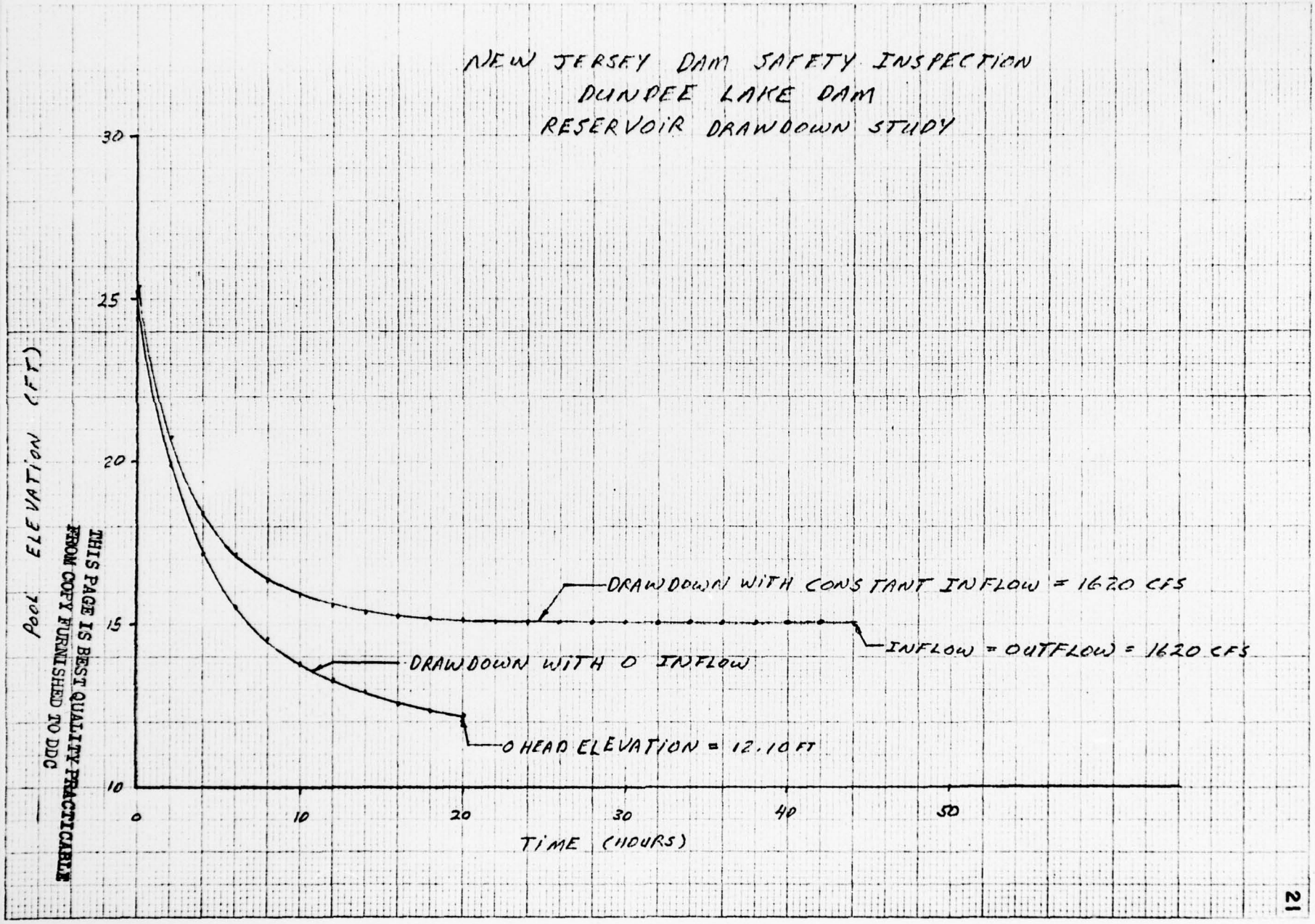
$= 11{,}372$ cfs

Assumed NWS = 25.4

Assumed Volume at NWS = 3584 Ac Ft.

Volume = 0 at ∴ 11.09.





DUNDEE LAKE DAM RESERVOIR DRAWDOWN STUDY (DA = 809.9 SQ. MI.)

1.0000 UNREGULATED DIVERSION CONDUIT AT ELEV 11.09 FT

MAXIMUM OPERATION LEVEL AT ELEV 25.40 FT (FROM OPERATI
MINIMUM OPERATION LEVEL AT ELEV 12.10 FT

ROUTING STARTS AT ELEV 25.40 FT, ENDS AT ELEV 12.10 FT

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
0	0		25.40			
		0.				
0	2		19.97	0.	0.	5559.
		0.				
0	4		17.18	0.	0.	3155.
		0.				
0	6		15.54	0.	0.	1966.
		0.				
0	8		14.49	0.	0.	1303.
		0.				
0	10		13.78	0.	0.	918.
		0.				
0	12		13.27	0.	0.	676.
		0.				
0	14		12.88	0.	0.	514.
		0.				
0	16		12.59	0.	0.	401.
		0.				
0	18		12.36	0.	0.	318.
		0.				
0	20		12.18	0.	0.	256.

****

RESERVOIR ELEVATION WENT UNDER MINIMUM WATERSURFACE ELEVATION
AFTER 0 DAYS AND 20 HOURS.

TOTAL INFLOW VOLUME 0. ACFT
TOTAL DISCHARGE VOLUME 3564. ACFT

MAXIMUM WATER SURFACE ELEVATION 25.40 FT

MAXIMUM DISCHARGE THRU DIVERSION CONDUIT 5559. CFS

MAXIMUM TOTAL INFLOW	0.	CFS
MAXIMUM TOTAL DISCHARGE	11372.	CFS

DUNDEE LAKE DAM RESERVOIR DRAWDOWN STUDY (DA = 609.9 SQ. MI.

1.0000 UNREGULATED DIVERSION CONDUIT AT ELEV 11.09 FT

MAXIMUM OPERATION LEVEL AT ELEV 25.40 FT (FROM RESERVO.
MINIMUM OPERATION LEVEL AT ELEV 12.10 FT

ROUTING STARTS AT ELEV 25.40 FT, ENDS AT ELEV 12.10 FT

TIME		AVG.INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
0	0		25.40			
		1620.				
0	2		20.77	0.	0.	6320.
		1620.				
0	4		18.44	0.	0.	4184.
		1620.				
0	6		17.13	0.	0.	3121.
		1620.				
0	8		16.36	0.	0.	2556.
		1620.				
0	10		15.88	0.	0.	2198.
		1620.				
0	12		15.56	0.	0.	1992.
		1620.				
0	14		15.38	0.	0.	1863.
		1620.				
0	16		15.25	0.	0.	1777.
		1620.				
0	18		15.17	0.	0.	1722.
		1620.				
0	20		15.11	0.	0.	1687.
		1620.				
0	22		15.08	0.	0.	1664.
		1620.				
1	0		15.05	0.	0.	1649.
		1620.				
1	2		15.04	0.	0.	1639.
		1620.				
1	4		15.03	0.	0.	1633.
		1620.				
1	6		15.02	0.	0.	1628.
		1620.				
1	8		15.02	0.	0.	1625.
		1620.				
1	10		15.02	0.	0.	1624.

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
1	12	1620.	15.01	0.	0.	1622.
1	14	1620.	15.01	0.	0.	1622.
1	16	1620.	15.01	0.	0.	1621.
1	18	1620.	15.01	0.	0.	1621.
1	20	1620.	15.01	0.	0.	1620.
1	22	1620.	15.01	0.	0.	1620.
2	0	1620.	15.01	0.	0.	1620.
2	2	1620.	15.01	0.	0.	1620.
2	4	1620.	15.01	0.	0.	1620.
2	6	1620.	15.01	0.	0.	1620.
2	8	1620.	15.01	0.	0.	1620.
2	10	1620.	15.01	0.	0.	1620.
2	12	1620.	15.01	0.	0.	1620.
2	14	1620.	15.01	0.	0.	1620.
2	16	1620.	15.01	0.	0.	1620.
2	18	1620.	15.01	0.	0.	1620.
2	20	1620.	15.01	0.	0.	1620.
2	22	1620.	15.01	0.	0.	1620.
3	0	1620.	15.01	0.	0.	1620.
3	2	1620.	15.01	0.	0.	1620.
3	4	1620.	15.01	0.	0.	1620.
3	6	1620.	15.01	0.	0.	1620.
3	8	1620.	15.01	0.	0.	1620.

TIME		AVG, INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
3	10	1620.	15.01	0.	0.	1620.
3	12	1620.	15.01	0.	0.	1620.
3	14	1620.	15.01	0.	0.	1620.
3	16	1620.	15.01	0.	0.	1620.
3	18	1620.	15.01	0.	0.	1620.
3	20	1620.	15.01	0.	0.	1620.
3	22	1620.	15.01	0.	0.	1620.
4	0	1620.	15.01	0.	0.	1620.
4	2	1620.	15.01	0.	0.	1620.
4	4	1620.	15.01	0.	0.	1620.
4	6	1620.	15.01	0.	0.	1620.
4	8	1620.	15.01	0.	0.	1620.
4	10	1620.	15.01	0.	0.	1620.
4	12	1620.	15.01	0.	0.	1620.
4	14	1620.	15.01	0.	0.	1620.
4	16	1620.	15.01	0.	0.	1620.
4	18	1620.	15.01	0.	0.	1620.
4	20	1620.	15.01	0.	0.	1620.
4	22	1620.	15.01	0.	0.	1620.
5	0	1620.	15.01	0.	0.	1620.
5	2	1620.	15.01	0.	0.	1620.
5	4	1620.	15.01	0.	0.	1620.
5	6	1620.	15.01	0.	0.	1620.

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
5	8	1620.	15.01	0.	0.	1620.
5	10	1620.	15.01	0.	0.	1620.
5	12	1620.	15.01	0.	0.	1620.
5	14	1620.	15.01	0.	0.	1620.
5	16	1620.	15.01	0.	0.	1620.
5	18	1620.	15.01	0.	0.	1620.
5	20	1620.	15.01	0.	0.	1620.
5	22	1620.	15.01	0.	0.	1620.
6	0	1620.	15.01	0.	0.	1620.
6	2	1620.	15.01	0.	0.	1620.
6	4	1620.	15.01	0.	0.	1620.
6	6	1620.	15.01	0.	0.	1620.
6	8	1620.	15.01	0.	0.	1620.
6	10	1620.	15.01	0.	0.	1620.
6	12	1620.	15.01	0.	0.	1620.
6	14	1620.	15.01	0.	0.	1620.
6	16	1620.	15.01	0.	0.	1620.
6	18	1620.	15.01	0.	0.	1620.
6	20	1620.	15.01	0.	0.	1620.
6	22	1620.	15.01	0.	0.	1620.
7	0	1620.	15.01	0.	0.	1620.
7	2	1620.	15.01	0.	0.	1620.
7	4	1620.	15.01	0.	0.	1620.

TIME		AVG.INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
7	6	1620.	15.01	0.	0.	1620.
7	8	1620.	15.01	0.	0.	1620.
7	10	1620.	15.01	0.	0.	1620.
7	12	1620.	15.01	0.	0.	1620.
7	14	1620.	15.01	0.	0.	1620.
7	16	1620.	15.01	0.	0.	1620.
7	18	1620.	15.01	0.	0.	1620.
7	20	1620.	15.01	0.	0.	1620.
7	22	1620.	15.01	0.	0.	1620.
8	0	1620.	15.01	0.	0.	1620.
8	2	1620.	15.01	0.	0.	1620.
8	4	1620.	15.01	0.	0.	1620.
8	6	1620.	15.01	0.	0.	1620.
8	8	1620.	15.01	0.	0.	1620.
8	10	1620.	15.01	0.	0.	1620.
8	12	1620.	15.01	0.	0.	1620.
8	14	1620.	15.01	0.	0.	1620.
8	16	1620.	15.01	0.	0.	1620.
8	18	1620.	15.01	0.	0.	1620.
8	20	1620.	15.01	0.	0.	1620.
8	22	1620.	15.01	0.	0.	1620.
9	0	1620.	15.01	0.	0.	1620.
9	2	1620.	15.01	0.	0.	1620.

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
		1620.				
9	4		15.01	0.	0.	1620.
		1620.				
9	6		15.01	0.	0.	1620.
		1620.				
9	8		15.01	0.	0.	1620.
		1620.				
9	10		15.01	0.	0.	1620.
		1620.				
9	12		15.01	0.	0.	1620.
		1620.				
9	14		15.01	0.	0.	1620.
		1620.				
9	16		15.01	0.	0.	1620.
		1620.				
9	18		15.01	0.	0.	1620.
		1620.				
9	20		15.01	0.	0.	1620.
		1620.				
9	22		15.01	0.	0.	1620.
		1620.				
10	0		15.01	0.	0.	1620.

TOTAL INFLOW VOLUME	33592.	ACFT
TOTAL DISCHARGE VOLUME	36392.	ACFT
MAXIMUM WATER SURFACE ELEVATION	25.40	FT
MAXIMUM DISCHARGE THRU DIVERSION CONDUIT	6320.	CFS
MAXIMUM TOTAL INFLOW	1620.	CFS
MAXIMUM TOTAL DISCHARGE	11372.	CFS

CONSULTING ENGINEERS

REVISED SUMMARY - Stability

COMPUTED BY TTM CHECKED BY

JOB NO. 10-7

DATE 6/21/78

30

(1.) CASE	(2.) CONDITIONS	(3.) LOCATION OF RESULTANT (FEET LEFT OF HEEL)	$\frac{\Sigma H}{\Sigma V}$	STRESS (PSI) HEAL	STRESS (PSI) TOE	RESISTANCE TO SLIDING SHEAR-FRICTION
I-A	HEADWATER @ ELEV. 25.4	11.76	.575	6.35	.728	27.23
I-B	TAILWATER @ ELEV. 11.9	9.51	.509	11.71	3.71	27.45
II-A	HEADWATER @ ELEV. 28.4	13.91	.775	2.21	9.67	23.02
II-B	TAILWATER @ ELEV. 14.9	11.10	.674	7.54	6.12	23.21
III-A	HEADWATER @ ELEV. 33.4	18.23	1.104	* 0	15.61	12.52
III-B	TAILWATER @ ELEV. 19.9	14.22	.933	1.67	9.82	19.74

* (62.2% of Base in Compression)

1. ALL "A" CASES ARE WITH 100% OF THE UPLIFT FORCES
   ALL "B" CASES REDUCTION IN UPLIFT FOR SEEPAGE PATH

2. FOR ALL CASES BACKFILL ON UPSTREAM FACE TO TOP OF DAM, SLOPING AWAY FROM DAM AT A 1 ON 3 SLOPE. TO ELEV. 12. (TOP OF ROCK)

3. MIDDLE THIRD OF DAM LIES BETWEEN 7.67' AND 15.34' TO THE LEFT OF THE HEEL.